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ORIGINAL ARTICLES.

I.—Note on the Piltdown Man (*Eoanthropus Dawsoni*).

By A. Smith Woodward, LL.D., F.R.S., Keeper, Geological Department, British Museum (Natural History).[1]

(PLATE XV.)

In a communication to the International Medical Congress recently reported in some of the English newspapers, Professor Arthur Keith expressed complete disapproval of my reconstruction of the skull and mandible of *Eoanthropus Dawsoni*.[2] I concluded that the brain capacity of this skull was comparable only with that of some of the lowest existing savages, while the mandible must have been provided in front with teeth of the ape pattern. Professor Keith, on the other hand, has restored the skull in such a manner as to have a brain capacity of 1,500 cubic centimetres, thus exceeding that of the average modern European. By distorting the curve of the front of the mandible he has also furnished it with completely human teeth. These two views, therefore, need careful examination before any definite conclusions can be drawn from this remarkable fossil.

Fortunately, Mr. Dawson has continued his diggings at Piltdown during the past summer, and on August 30 Father P. Teilhard, who was working with him, picked up the canine tooth which obviously belongs to the half of the mandible originally discovered. In shape it corresponds exactly with that of an ape, and its worn face shows that it worked upon the upper canine in the true ape fashion. It only differs from the canine of my published restoration in being slightly smaller, more pointed, and a little more upright in the mouth. Hence we have now definite proof that the front teeth of *Eoanthropus* resembled those of an ape, and my original determination is justified.

It may next be questioned whether this ape-like mandible belongs to the skull. We can only state that its molar teeth are typically human, its muscle-markings are such as might be expected, and it was found in the gravel near to the skull. The probabilities are

[1] Abridged from a lecture delivered to the British Association, Birmingham, September 16, 1913.

[2] C. Dawson & A. S. Woodward, "On the Discovery of a Palæolithic Skull and Mandible in a Flint-bearing Gravel overlying the Wealden (Hastings Beds) at Piltdown, Fletching (Sussex)," Quart. Journ. Geol. Soc., vol. lxix, pp. 124–39, pls. xviii–xx, 1913.

therefore in favour of its natural association. If so, it is reasonable to suppose that the skull will prove to be that of a very primitive type, not that of a highly civilized man. I have accordingly made a new study of the specimen, with the special help of my colleague, Mr. W. P. Pycraft, and I find that the only alteration necessary in my original model (made by Mr. Frank O. Barlow) is a very slight displacement of the occipital and right parietal bones, which Professor Elliot Smith pointed out to me when he made his first studies of the brain. Both behind and in front I correctly identified the internal groove for the upper longitudinal blood-sinus, which marks the middle line of the roof of the skull; and the reason why my adjustment of the occiput was not exact at first is, that on the hinder part of the parietal region of the skull-roof I noticed a longitudinal ridge which I supposed to be truly median, while the extraordinarily unsymmetrical development of the brain seemed to have pushed the longitudinal sinus at that part slightly out of its normal place. I now know that the longitudinal ridge is one of a pair. The change, however, only opens the upper part of the skull behind to an extent of three-quarters of an inch, and there are compensations elsewhere through the necessary readjustments, so the total brain capacity remains nearly the same as that I originally stated, well within the range of the smallest human brains of the present day.

I may add that I have submitted the new brain-cast to Professor Elliot Smith, who allows me to state that he finds it in all essential respects correct. He will shortly describe it in a memoir on fossil human brains to be read before the Royal Society.

EXPLANATION OF PLATE XV.

EOANTHROPUS DAWSONI, A. S. Woodw.; from a Pleistocene gravel near Piltdown Common, Fletching, Sussex.

FIG. 1. Right side-view of skull and mandible. One-third nat. size.

,, 2. Outer view of right mandibular ramus, with the canine tooth placed in natural position. Two-thirds nat. size.

II.—"THE ORIGIN OF MOUNTAINS": A REPLY.

By the Rev. O. FISHER, M.A., F.G.S.

I AM content to leave to the readers of the GEOLOGICAL MAGAZINE the question whether Colonel Burrard's theory of the elevation of mountains and Mr. Hayford's of the distribution of density to cause isostasy are more in accordance with geological phenomena than my theory of mountain roots supported in a dense liquid substratum. But in Colonel Burrard's reply[1] to my paper in the Magazine for June there is a fundamental but specious error. I wrote: "Is it not possible that the earth's rotation may impart to it a 'gyroscopic' *quasi* rigidity, which may enable it to withstand the deforming influence of external forces [the attraction of the moon and sun], although at the same time forces internal to the earth will

[1] This Magazine, September, 1913.

be unaffected by it." To this Colonel Burrard replies: "Mr. Fisher has argued that the rotation of the earth will give to the liquid interior an effective rigidity; but this rotation has conferred no rigidity upon our oceans, and even if it did render the liquid interior rigid, it would only do so in low latitudes where the rotation velocity is high. I understand, moreover, that the earth's interior was assumed by Mr. Fisher to be liquid, in order to explain the floatation of the crust. If the liquid is now proved to be rigid, the crust cannot be floating upon it." Colonel Burrard forgets that the ocean and the earth's crust, being part of the rotating mass, the forces acting on them are *internal*, and will not be affected by the gyroscopic rigidity, which exists only with reference to *external* forces. It is true that this rigidity will be greatest in the equatorial regions, but it is in those regions that the tidal forces chiefly act, and require to be, and are, met by this theory.

Colonel Burrard asks, "How can computers test a theory when the limits and size of the roots are not exactly defined?" My answer is, how can I define the limits and size of the roots, believing as I do that mountains are partly supported by the rigidity of the crust? Is it likely that where the crust has been thickened by compression, part being sheared upwards and part downwards into the substratum, the compressed area should have become detached from the adjoining crust, so as not to depress it to some distance away, along with it? And if that depression became covered by detritus it also would appear to have a root. In fact, the simplicity, very naturally desired by geodesists, is not to be expected. But the lack of it does not condemn the theory of mountains having roots projecting into a dense liquid substratum, and that this arrangement tends to produce isostasy.

In a note at p. 387 Colonel Burrard controverts my argument against solidity, drawn from the observed changes of gravity since 1873 at Dehra Dun; and says that the change is apparent only and due to the vibration of the pendulum's support. But in his paper at the Royal Society, 1906, he wrote: "The only faults which have been found with their [the observers' of 1865–73] work, are such as would tend to produce constant error." And he gives the following list:—

"The force of gravity as observed by—

	Basevi and Heaviside, 1865–73. cm.	Lenox Conyngham, 1904. cm.	Difference. cm.
Dehra Dun. . . .	978·962	979·065	+0·103
Madras	978·237	978·281	+0·044
Bombay	978·605	978·632	+0·027
Mupooner	978·751	978·795	+0·044"

Now it will be seen that the difference at the four stations mentioned is *not* constant, but is more than twice as great at Dehra Dun than at the other three. This would be in accordance with the changes still said to be going on there, to which I referred as reported in *Nature*.

III.—Notes on new or imperfectly known Chalk Polyzoa.

By R. M. Brydone, F.G.S.

(*Continued from the June Number, p. 250.*)

(PLATE XIV.)

Cribrilina Gregoryi, mihi.[1] (Pl. XIV, Figs. 1–3.)

THE original figure of this species was rather diagrammatic and requires supplementing. Figs. 1 and 2 are from the type-specimen, Fig. 2 being given to illustrate the rectangular aperture which the species has a tendency to develop, though quite irregularly; this rectangular outline appears to be due to the amalgamation of the two prominent tubercles into a straight-edged cap which hides the arched part of the upper lip and may be oœcial in function. The typical form of the species is definitely established in the *Marsupites* zone (= *Marsupites* band of many authors), though it only becomes abundant in the succeeding zone.

Fig. 3 illustrates a form which occurs sparingly in the upper part of the zone of *M. cor-anguinum*, free-growing specimens of which have the strongly punctate basal lamina of this species, and which I regard as probably a developmental stage of it; distinct traces are shown of an aperture with six tubercles on the upper lip, four of which fail to persist.

Cribrilina suffulta, sp. nov. (Pl. XIV, Figs. 4, 5.)

Zoarium unilaminate, adherent.

Zoœcia practically zoœcia of a typical pyriform *Membranipora* such as *M. Triminghamensis, mihi*,[1] with a highly arched Cribrilinid front wall added; the front wall is in two sections, divided longitudinally by a stout rib; the outer section rises at a steep angle from the side walls to support this rib, and is pierced by a series of narrow radiating slits; the inner section is enclosed by a row of pores along the inner side of the rib, corresponding very regularly with the slits outside; it is markedly depressed and has a few pores scattered irregularly over it; the aperture is roughly semicircular, its lower lip being strongly arched, as it is formed by the thickened edge of the arched front wall, while its upper lip is flat and bears very faint tubercles, apparently five in number normally.

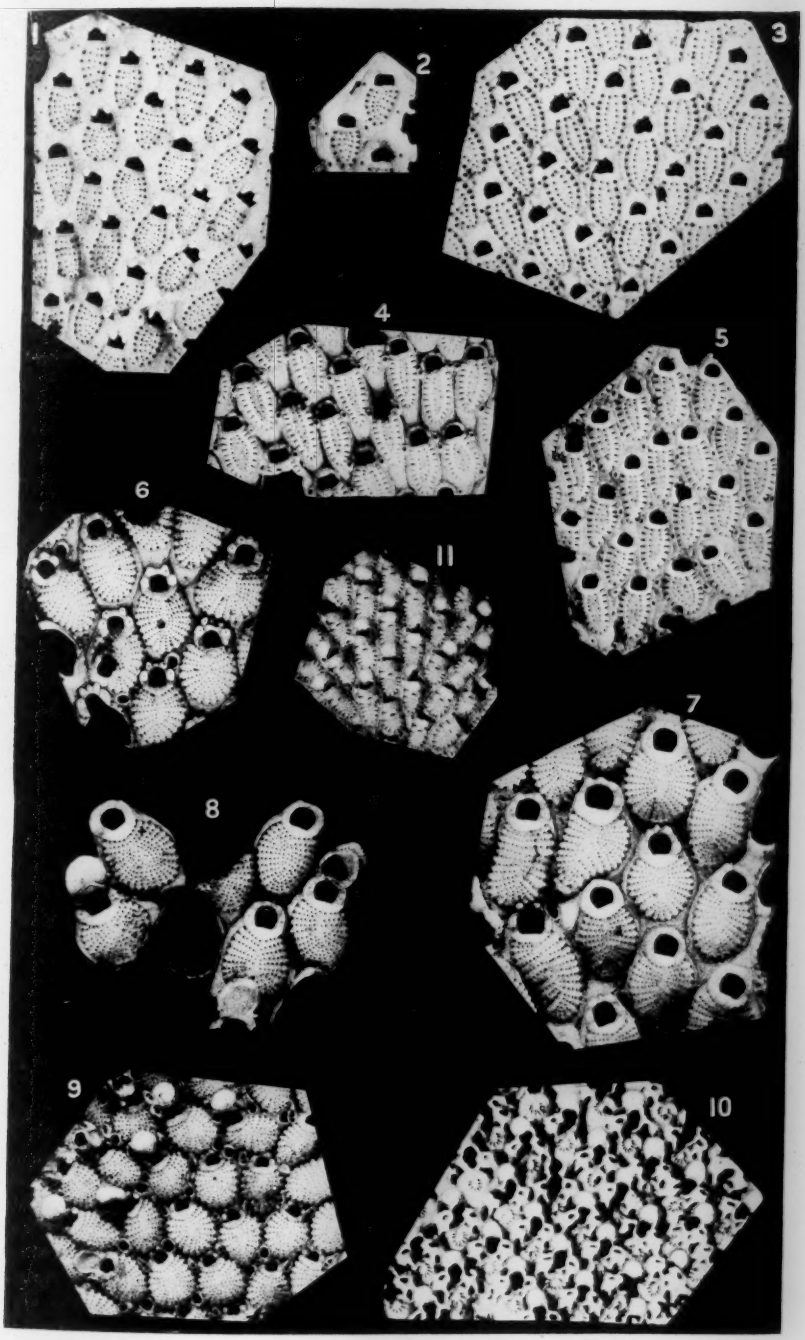
Oœcia probably represented by wide, shallow, hood-like swellings of the upper lip, having a straight free edge, which make the apparent outline of the aperture quite sharply oblong.

Avicularia corresponding very closely in shape, size, and disposition with those of *C. Gregoryi*.

This species occurs in the *cor-anguinum* zone and *Uintacrinus* band sparingly, and I have a specimen from the zone of *O. pilula* (sub-zone of abundant *O. pilula*). It is obviously intermediate between *Cribrilina* and *Membraniporella*, and, in accordance with my previous practice in such cases, I have attributed it to the former.

The normal aspect of the species (Fig. 4) presents little obvious relationship to *C. Gregoryi*, but in Fig. 5 I have illustrated a specimen which I think must be regarded as a coarse form of *C. suffulta*, and which

[1] Geol. Mag., 1906, pp. 289–300.



R. M. Brydone, Photo. Bemrose, Collo.

Chalk Polyzoa.

shows a very close approach to the early coarse form of *C. Gregoryi* illustrated by Fig. 3, and makes it important to inquire what sure distinctions can be drawn between these species. The most prominent feature of *C. suffulta* is the arched front wall with depressed central area—it does not show up well under the microscope but is very striking under a pocket lens—but this feature is occasionally very closely imitated, owing no doubt to local conditions, in an otherwise typical zoarium of *C. Gregoryi*. But the slits in the front wall, which in *C. suffulta* replace pores in *C. Gregoryi*, and the stout paired tubercles at the upper end of the aperture of *C. Gregoryi*, seem to be absolutely reliable distinctions.

Cribrilina Cacus,[1] sp. nov. (Pl. XIV, Figs. 6–8.)

Zoarium unilaminate, always encrusting.

Zoœcia subpyriform and very large for this genus, such measurements as 1·2 mm. for length and ·9 mm. for breadth being quite usual; side walls quite distinct; front walls lying on the side walls, flatly convex, pierced by from twenty to twenty-six rows of pores more or less opposed in pairs, the pores tending to increase markedly in size at the outer ends of the rows; aperture definitely but not strongly horseshoe-shaped and bearing on its rim four or five more or less perforated tubercles, the lower pair much stouter and less deeply perforated than the upper ones, while when three upper ones are present the middle one of them tends to be distinctly more slender than the others.

Oœcia quite scarce and very brittle, the one figured (Fig. 8) being the only perfect one I have yet seen: it was very large and globular with a tendency to a bottle neck, and two stay-like rods running obliquely upwards to it from the sides of the aperture; unfortunately it was destroyed by an accident after it had been photographed.

Avicularia perhaps represented by shallow, slightly ear-shaped rings sparingly tucked away among the zoœcia, resembling those more freely found in *Cribrilina Dibleyi, mihi*.[2]

This species, which occurs from time to time at Trimingham, might almost be regarded as a double scale variety of *C. Dibleyi*, a figure of which is given for comparison. At the same time, this giant form occurs often enough to indicate the existence of a definite race; and as there are no intermediate forms, and the difference in size is so considerable, I have thought it justifiable to constitute it a separate species. Support may be found for this view in the differing shapes of the respective apertures and the total absence from *C. Cacus* of anything to correspond with the graceful and abundant avicularia of *C. Dibleyi*. *Cribrilina Guascoi*, Ubaghs, sp. (*Escharipora Guascoi*, Ubaghs, *Verh. d. Nat. Ver. Preussen Rheinl.*, Jahrg. xxii, p. 51, taf. ii, fig. 3), seems a close parallel in size and general type.

Membraniporella Sherborni, mihi sp. (Pl. XIV, Fig. 10.)

Syn. *Cribrilina Sherborni, mihi*.[2]

Further investigation has shown that the radiating ribs of the front wall are not united to one another in any way, and the species must

[1] Cacus, a giant in Latin mythology.

[2] Geol. Mag., 1906, pp. 289–300.

therefore be classed as a *Membraniporella*. A photographic figure of a suitable specimen is given to supplement the original diagrams.

MEMBRANIPORELLA JUKES-BROWNEI, mihi sp. (Pl. XIV, Fig. 11.)

Syn. *Cribrilina Jukes-Brownei, mihi.*[1]

Here, too, the structure of the front wall appears to involve the transference of the species to *Membraniporella*, and the original diagrams are supplemented by a photographic figure. Restudy of this species has left me with a strong impression that it is closely related to, if not directly descended from, *Membraniporella fallax, mihi*, notwithstanding the considerable difference there is between them at first sight.

EXPLANATION OF PLATE XIV.

(All figures × 12 diams.)

FIGS. 1, 2. *Cribrilina Gregoryi*. Different parts of type-specimen. Zone (restricted) of *A. quadratus*. Upham, Hants.
FIG. 3. *C. Gregoryi*. Zone of *M. cor-anguinum*. Basingstoke.
FIGS. 4, 5. *C. suffulta*, sp. nov. Zone of *M. cor-anguinum*. Gravesend.
FIGS. 6–8. *C. Cacus*, sp. nov. Trimingham.
FIG. 9. *C. Dibleyi*. ,,
,, 10. *Membraniporella Sherborni*. Trimingham.
,, 11. *M. Jukes-Brownei*. ,,

IV.—CLASSIFICATION OF YOUNGER STRATIFIED FORMATIONS OF NEW ZEALAND.

By Professor JAMES PARK, F.G.S., Otago University, Dunedin, New Zealand.

I DO not think there is likely to be much gain from a prolonged discussion of this matter, and for the present I shall content myself with a brief recapitulation of the position so far as it affects the views of Dr. P. Marshall on the one hand and of Captain Hutton and myself on the other.

1. At various places in the maritime regions of New Zealand, throughout a length of 1,000 miles, there exist a Cretaceous succession and a Lower Tertiary succession of sedimentary strata. Both successions contain several fossiliferous horizons, and in many places fossils are numerous and well preserved. By the aid of these fossiliferous horizons the Geological Survey has been able to divide these strata into eight easily recognizable series.

The Cretaceous strata always rest on Jurassic or older rocks. The Lower Tertiary beds rest sometimes on the Cretaceous strata, but most often on formations older than Cretaceous.

In the central regions of New Zealand, as at Waipara, Weka Pass, Clarence Valley, Akiteo, and Poverty Bay, the physical unconformity between the Cretaceous and Lower Tertiary is absurdly slight, so slight that it cannot be distinguished in many single sections. At each end of this central region, as at Shag Point and Kaitangata in Otago, and Wade and Kaipara in North Auckland, the conformity is quite clear and unmistakable.

Captain Hutton's first acquaintance with the Lower Tertiary and Cretaceous strata was made in the East Cape and North Canterbury

[1] GEOL. MAG., 1906, pp. 289–300.

districts, and their apparent stratigraphical conformity led him in the early seventies to establish his Cretaceo-Tertiary System. Even at that time he clearly recognized the purely secondary character of the fauna of the Cretaceous element of the succession, and the equally distinctive Tertiary facies of that prevailing in the uppermost strata. There was no commingling of Cretaceous and Tertiary types, and, realizing that a Cretaceo-Tertiary System could not be maintained on purely stratigraphical grounds, he unhesitatingly abandoned his own creation.

The Geological Survey, which adopted Hutton's Cretaceo-Tertiary System from the first, continued to support it for some years; but for the past quarter of a century the Survey has offered no defence of it.

Dr. Marshall viewed the Weka Pass sections two or three years ago, and in his maiden flight in the domain of classification 'lumped' all the Cretaceous and Tertiary strata into one system, which he designated his "Oamaru System (Cainozoic—mostly early)". A Tertiary system containing *Baculites*, *Ammonites*, *Inoceramus*, *Belemnites*, as well as *Plesiosaurus*, *Mosasaurus*, and other secondary reptiles, is a geological curiosity of a very novel kind. This is a grave blunder which fortunately carries its own correction. It appears to have arisen from an exaggerated notion of the value of physical conformity in the role of classification. For the past century the main and minor subdivisions of the geological record have been based on palæontological grounds alone. No dependence can be placed on physical conformities and unconformities, which are simply an expression of local geographical conditions.

2. So much for the general discussion. Turning to some details in Dr. Marshall's letter in your June number, he states that "where the Amuri Limestone has been found there is a thickness of 500 to 2,000 feet of strata that have up to the present time yielded no fossils". This is an error, and apparently made in ignorance of the fact that the Geological Survey has found Cretaceous fossils right up to the base of the Amuri Limestone in the Clarence Valley and at Amuri Bluff. Moreover, Dr. Marshall omits to mention the fact that no Tertiary fossils have ever been found below the Amuri Limestone in any part of New Zealand.

3. Dr. Marshall states that the stratigraphical break between the Cretaceous and Lower Tertiary strata as exposed at Orewa and Kaipara is due to slipped ground. The too frequent appeal to the hypothetical slip lacks conviction. These sections were first described and figured by me over twenty-five years ago, and on account of their important bearing on the relationship of the Tertiary and Cretaceous systems were subsequently critically examined by Sir James Hector and Alex. McKay. These experienced geologists made no attempt to evade the obvious evidence of unconformity.

4. Dr. Marshall represents me as saying that I had not previously to 1912 critically examined the surface of the Amuri Limestone for Hutton's unconformity. My paper on the "Lower Tertiary Rocks of New Zealand",[1] with my description and sections of the Weka Pass district, should have made it clear enough that I did not refer to the

[1] Trans. N.Z. Institute, vol. xxxvii. 1904.

surface of the Amuri Limestone as exposed at Weka Pass, but to the exposures at the Upper Waipara, where fossils were recently found in the Weka Pass Stone by Dr. Thomson and concerning which I was writing at the time.[1]

The evidence of an unconformity between the Weka Pass Stone and Amuri Limestone at Weka Pass is very meagre, but at the Upper Waipara the corroded, shattered, and brecciated upper surface of the Amuri Limestone certainly favours Hutton's view of unconformity; and comparing the evidence with that I have seen at the junction of the Eocene and Cretaceous in the section across the Isle of Wight, in the Hampshire Basin, in different parts of the Gallic Basin, in North-West Germany, and in Northern Africa, I have no doubt that European geologists would support Hutton's contention. But the question after all is not dependent on physical conformity or unconformity, but on the broader platform of palæontology. So long as a Cretaceous fauna is held to typify a Cretaceous age and a Tertiary fauna a Tertiary age, so long must Hutton's Waipara and Oamaru Systems stand as typical of New Zealand's Cretaceous and Lower Tertiary formations respectively.

V.—On the Important Part played by Calcareous Algæ at certain Geological Horizons, with Special Reference to the Palæozoic Rocks.

By Professor E. J. Garwood, M.A., V.P.G.S.[2]

More than twenty years ago, whilst engaged in the study of the Lower Carboniferous rocks of Westmorland, I noticed the occurrence of certain small concretionary nodules of very compact texture in the dolomites near the base of the succession in the neighbourhood of Shap.

Shortly afterwards, when examining the Bernician rocks of Northumberland, I again met with similar compact nodular structures. It was obvious, however, even at that time, that the Northumberland specimens occurred here at a much higher horizon than those which I had observed in Westmorland.

More recently, whilst studying the lithological characters of the Lower Carboniferous rocks of the North of England and the Border country, I have been still further impressed by the abundance of these nodular structures at several horizons, and the large tracts of country over which they extend. An examination of these nodules in thin sections showed their obvious organic character, and I was at first inclined to refer them to the Stromatoporoids. Dr. G. J. Hinde, who was kind enough to examine my specimens from the Shap district, reported, however, that they were probably not Stromatoporoids, but Calcareous Algæ,[3] and referred me to the descriptions of *Solenopora* published by the late Professor Nicholson and Dr. Brown.

[1] "The Supposed Cretaceo-Tertiary Succession of New Zealand," Geol. Mag., November, 1912, pp. 496–7.

[2] Being the substance of his address to the Geological Section of the British Association for the Advancement of Science, Birmingham, 1913 (President of Section C).

[3] See Geol. Mag., 1913, pp. 289–92, Pl. X: Dr. G. J. Hinde on *Solenopora*.

Since then I have examined a large number of nodules collected from different horizons in the Lower Carboniferous rocks of Britain and Belgium, and the examination has convinced me that the remains of Calcareous Algæ play a very much more important part in the formation of these rocks than has hitherto been generally realized.

The majority of geologists in this country have been slow to recognize the importance of these interesting organisms, and, with the notable exception of Sir Archibald Geikie's textbook, we find but scant allusion in English geological works of reference to the important part played by Calcareous Algæ in the formation of limestone deposits.[1]

From the more strictly botanical standpoint, however, we are indebted to Professor Seward for an admirable account of the forms recognized as belonging to this group up to the date of the publication of his textbook on Fossil Plants in 1898; while in an article in *Science Progress* in 1894 he has also dealt with their importance from a geological point of view.

Since these publications, not only have several new and important genera been discovered in this country and abroad, but the forms previously known have also been found to have a very much wider geological and geographical range than was formerly suspected. For these reasons I venture to hope that a summary of our knowledge of the part they play as rock-builders, more especially in British deposits, will serve to stimulate an interest among geological workers in this country in these somewhat neglected organisms.

Previous to 1894, in which year Dr. Brown first referred *Solenopora* to the Nullipores, with the exception of the Jurassic and Tertiary Characeæ, we meet with little, if any, reference to the occurrence of fossil Calcareous Algæ in British deposits.

Indeed, in this country the subject has attracted but few workers, and they can almost be counted on the fingers of one hand. When we have mentioned the late Professor H. A. Nicholson and Mr. Etheridge, jun., Mr. E. Wethered, Dr. Brown, Dr. Hinde, and Professor Seward, we have practically exhausted the list of those who have contributed to our knowledge of the subject. To these we may add the name of Mrs. Robert Gray, whose magnificent collection of fossils from the Ordovician rocks of the Girvan district has always been freely placed at the disposal of geological workers, and has furnished numerous examples of these organisms to Professor Nicholson and the officers of the Geological Survey.

It was Nicholson and Wethered who first recognized the important part played in the formation of limestones by certain organisms, which, though referred at the time to the animal kingdom, are now generally considered to represent the remains of Calcareous Algæ.

The presence of these organisms in a fossil state, especially in the older geological formations, has only been recognized in comparatively recent years; though it was suggested as long ago as 1844 by Forchhammer[2] that fucoids, by abstracting lime from sea water, probably contributed to the formation of Palæozoic deposits. When

[1] Geikie, *Textbook of Geology*, 4th ed., vol. i, pp. 605, 611, 1903.
[2] British Association, 1844, p. 155.

we remember that it was not until the researches of Philippi were published in 1837 that certain calcareous deposits were discovered to be directly due to the growth of living forms of lime-secreting algæ, it is not surprising that only in comparatively recent years has the importance of the fossil forms as rock-builders in past geological formations been recognized.

The original genera established by Philippi—namely, *Lithothamnion* and *Lithophyllum*—are known now to have a wide distribution in the present seas, and it is therefore natural that it was members of these groups which were the first to be recognized in a fossil state in Tertiary and, subsequently, in Upper Cretaceous rocks.

Thus in 1858 Professor Unger, of Vienna, showed the important part played by *Lithothamnion* in the constitution of the Leithakalk of the Vienna Basin, while seven years later Rosanoff contributed further to our knowledge of Tertiary forms. In 1871 Gümbel published his monograph on the "so-called Nullipores found in limestone rocks", with special reference to the *Lithothamnion* deposits of the Danian or Maestricht beds. Since then *Lithothamnion* has also been reported from Jurassic rocks, and even from beds of Triassic age, though in the latter case, at all events, the reference to this genus appears to require confirmation. In this country the recognition of fossil Calcareous Algæ dates from a considerably later period. It will be best first to review the chief genera which appear to be referable to the Calcareous Algæ, and afterwards to show the part they play as rock-builders in the different geological formations.

Two important genera are usually recognized at the present day as occurring in the British Palæozoic and Mesozoic rocks—namely, *Solenopora* and *Girvanella*—and to these I propose to add Wethered's genus, *Mitcheldeania*, together with certain new forms from the Carboniferous rocks of the North of England, which appear also to be referable to this group.

Solenopora.

This genus was first created by Dybowski in 1877 for the reception of an obscure organism, from the Ordovician rocks of Esthonia, which he described under the name *Solenopora spongioides* and regarded as referable to the Monticuliporoids.

Nicholson and Etheridge in 1885 (Geol. Mag., p. 529) showed that the form described by Billings in 1861 as *Stromatopora compacta*, from the Black River limestones of North America, was in reality Dybowski's genus *Solenopora*, and in all probability was specifically identical with the form from Esthonia. Moreover, they considered that the organism they themselves had described under the name of *Tetradium Peachii* in 1877, from the Ordovician rocks of Girvan, was also referable to Billing's species, though perhaps a varietal form. Thus *Solenopora compacta* was shown to have a very wide distribution in Ordovician times.

Nicholson in 1888 defined the genus as including "Calcareous organisms which present themselves in masses of varying form and irregular shape, composed wholly of radiating capillary tubes arranged in concentric strata. The tubes are in direct contact, and no

cœnenchyma or interstitial tissue is present. The tubes are thin-walled, irregular in form, often with undulated or wrinkled walls, without mural pores, and furnished with more or fewer transverse partitions or tabulæ".[1]

At that time Nicholson still considered *Solenopora* as representing a curious extinct hydrozoon, though already, in 1885, Nicholson and Etheridge had discussed its possible relationship to the Calcareous Algæ. They did not, however, consider that there was sufficient evidence for concluding that the true structure of *Solenopora* was cellular, but added: "If evidence can be obtained proving decisively the existence of a cellular structure in *Solenopora*, then the reference of the genus to Calcareous Algæ would follow as a matter of course."[2]

In 1894 Dr. A. Brown[3] investigated more fully the material which had been placed in his hands by Professor Nicholson, and gave an account of all the forms referable to *Solenopora* known at that date.

To those already recorded he added descriptions of four new species from the Ordovician rocks—namely, *S. lithothamnioides*, *S. fusiformis*, *S. nigra*, and *S. dendriformis*, the two latter being from the Ordovician rocks of Esthonia.

In the same paper also he published for the first time a description of a new species of *Solenopora* from the Jurassic rocks of Britain, to which Nicholson, in manuscript, had already assigned the name of *S. jurassica*, though, as will be pointed out later, it is probable that two distinct forms were included by Brown under this name.

This record of *Solenopora* from the Lower Oolites of Britain extended the known range of this genus, for the first time, well into the Jurassic period. In this paper Brown first brought forward good evidence for removing *Solenopora* from the animal kingdom, and placing it among the Coralline Algæ, and Professor Seward, in vol. i of his work on *Fossil Plants*, considers that there are good reasons for accepting this conclusion.

At the time of the publication of Dr. Brown's paper, and for some years afterwards, the only formations in which *Solenopora* was known to occur were the Upper Ordovician and the Lower Oolites. The diversity of forms, however, met with in the Ordovician rocks, and their widespread distribution, pointed to the probability of the existence of an ancestral form in the older rocks, while it also appeared incredible that no specimens of intervening forms should have been preserved in the rocks representing the great time-gap between the Ordovician and Jurassic formations.

In this connexion Professor Seward remarks[4]: "It is reasonable to prophesy that further researches into the structure of ancient limestones will considerably extend our knowledge of the geological and botanical history of the Corallinaceæ." This prophecy has been amply fulfilled, especially as regards this particular genus, and recent discoveries go far towards filling the previously existing gaps in our knowledge of the vertical distribution of this interesting genus.

[1] GEOL. MAG., Dec. III, Vol. V, p. 19, 1888.
[2] GEOL. MAG., Dec. III, Vol. II, p. 534, 1885.
[3] GEOL. MAG., Dec. IV, Vol. I, pp. 145 and 195, 1894.
[4] *Fossil Plants*, vol. i, p. 190, 1898.

Thus the recent detection in the lowest Cambrian rocks of the Antarctic Continent of a form which appears to be referable to this genus enables us to trace the ancestry of *Solenopora* back almost to the earliest rocks in which fossils have yet been discovered, while the gap in the succession which previously existed between the Ordovician and Jurassic forms was decreased by the description in 1908 by Professor Rothpletz of a new species *Solenopora gotlandica*, from the Silurian rocks of Faröe Islands in Gotland.[1] A large number of deposits, however, still remained, between the Gotlandian and Lower Jurassic beds, from which no example of *Solenopora* had so far been recorded.

The identification, therefore, a few years ago, by Dr. G. J. Hinde, of examples of this genus from among the nodules I had collected from the Shap dolomites, is of considerable interest, as the presence of *Solenopora* in the Lower Carboniferous rocks of this country materially decreases the gap in our knowledge of the succession of forms belonging to this genus which had previously existed.

Girvanella.

This organism, which is now known to be widely distributed in the Palæozoic and Mesozoic rocks of this country, was originally described in 1878 by Nicholson and Etheridge, jun., from the Ordovician rocks of the Girvan district. The genus was established to include certain small nodular structures composed of a felted mass of interlacing tubes, having a width of 10 and 18 μ, the cells being typically simple, imperforate tubes without visible internal partitions. The geno-type, *G. problematica*, was, however, at that time referred to the Rhizopods and regarded as related to the arenaceous foraminifera.[2] In 1888 Nicholson, in redescribing this genus in the Geological Magazine, compares *Girvanella* with the recent form *Syringammina fragillissima* of Brady.

More recently Mr. Wethered has shown that an intimate association frequently exists between *Girvanella* tubes and oolitic structure, and he has described several new species of *Girvanella* from the Palæozoic rocks and also from certain Jurassic limestones.

The reference of *Girvanella* to the Calcareous Algæ, though not yet supported by incontestable evidence, has been advocated by several writers in recent years. Even as long ago as 1887, Bornemann, in describing examples of *Siphonema* (*Girvanella*, Nich.) which he had discovered in the Cambrian rocks of the Island of Sardinia, suggested that this organism might belong to the Calcareous Algæ.

In 1891 Rothpletz[3] noticed that some of the specimens of *Girvanella* which he had examined were characterized by dichotomous branching of the tubes; on this account he removed the genus from the Rhizopods to the Calcareous Algæ, placing it provisionally among the Codiaceæ. Three years later Dr. A. Brown, in summing up the evidence in favour of the inclusion of *Solenopora* among the Nullipores, expressed

[1] *Kungl. Svenska, Vets. akad. Handl.*, Bd. 43, No. 5, pl. iv, pp. 1–5 and 14, 1908.

[2] *Silurian Fossils in the Girvan District*, 1878, p. 23.

[3] Zeitschr. d. D. Geol. Gesell., 1891.

the opinion that *Girvanella* might ultimately come to be regarded as referable to the Siphoneæ Verticillatæ.

In 1898, however, this genus was still only doubtfully placed with the Calcareous Algæ, for Seward, in his work on *Fossil Plants*,[1] remarks: "The nature of *Girvanella*, and still more its exact position in the organic world, is quite uncertain. . . . We must be content for the present to leave its precise nature still *sub judice* and, while regarding it as probably an alga, we may venture to consider it more fittingly discussed among the Schizophyta than elsewhere."

In 1908, however, Rothpletz, in discussing the relationship of *Spherocodium* and *Girvanella*, reaffirms his opinion that the latter must be referred to the Codiaceæ.[2]

Mitcheldeania.

This genus was first described by Mr. Edward Wethered from the Lower Carboniferous beds of the Forest of Dean[3] under the name of *Mitcheldeania Nicholsoni*; it was referred by him to the Hydractinidæ, and considered to be allied to the Stromatoporoids. The figure accompanying this paper unfortunately fails to show any of the characters of the organism, but a better figure of the same species was subsequently published in the Proceedings of the Cotteswold Naturalists' Field Club.[4]

In 1888 Professor H. A. Nicholson published in the Geological Magazine[5] figures and descriptions of a new species of this genus (*M. gregaria*), and redefined the genus as having "the form of small, rounded or oval calcareous masses made up of capillary tubes of an oval or circular shape, which radiate from a central point or points, and are intermixed with an interstitial tissue of very much more minute branching tubuli". He compares the larger tubes to zooidal tubes, and states that they "communicate with one another by means of large, irregularly-placed foramina resembling 'the mural pores' of the Favositidæ, and they occasionally exhibit a few irregular transverse partitions or tubulæ".

With regard to the systematic position of this genus Nicholson remarks: "In spite of the extreme minuteness of its tissues, the genus *Mitcheldeania* may, I think, be referred with tolerable certainty to the Cœlenterata . . . its closest affinities seem to be with the Hydrocorallines . . . on the other hand all the known Hydrocorallines possess zooidal tubes which are enormously larger than those of *Mitcheldeania*; and there are other morphological features in the latter genus which would preclude its being actually placed, with our present knowledge, in the group of the *Hydrocorallinæ*."

Since this description by Professor Nicholson no further account of this organism, so far as I am aware, has been published, and its reference to the *Hydrozoa* rests on Professor Nicholson's description.

During the past few years I have collected a large amount of material from both of the type localities from which Mr. Wethered

[1] Op. cit., vol. i, p. 125.
[2] Rothpletz, Kungl. Sven. Vets. Akad. Hardl., Bd. 43, No. 5, loc. cit., 1908.
[3] Geol. Mag., Dec. III, Vol. III, p. 535, 1886.
[4] Vol. ix, p. 77, pl. v, 1886.
[5] Op. cit., p. 16.

and Professor Nicholson obtained their specimens, and an examination of this material has impressed me strongly with the resemblance of *Mitcheldeania* to forms such as *Solenopora* and *Girvanella*, now usually classed among the Calcareous Algæ. In the rocks in which it occurs *Mitcheldeania* appears as rounded and lobulate nodules, breaking with porcellanous fracture and showing concentric structure on weathered surfaces, very similar to nodules of *Solenopora*; while under the microscope the branching character of the tubules and their comparatively minute size appear to separate them from the Monticuliporoids. Professor Nicholson appears to rely on the presence of pores, which he thought he observed in the walls of both the larger and finer tubes, for the inclusion of this genus with the Hydrocorallines, though he appeared to be doubtful about their occurrence in the interstitial tubuli. An examination of a large number of slides has failed to convince me of the presence of pores, even in the larger 'zooidal tubes'. The large 'oval or circular' apertures noticed by Nicholson appear to be either elbows in the undulating tubes cut across where these bend away from the plane of the section, or places where a branch is given off from a tube at an angle to the plane of the section. If this view be accepted, there appears to be no sufficient reason why *Mitcheldeania* should not be ranged with *Solenopora* and other similar forms, and included among the Calcareous Algæ—a position which its mode of occurrence and general structure has led me, for some time, to assign to this organism.

In addition to the three chief forms described above from British rocks, a study of numerous thin sections from the Lower Carboniferous rocks of the north-west of England has revealed the presence of several distinct organisms, which will, I think, eventually be found to be referable to the Calcareous Algæ.

This meagre list appears to exhaust the genera known at the present time from the Lower Carboniferous rocks of Britain, while the only additional genus so far recorded from the Mesozoic and Tertiary rocks of this country (if we accept Rothpletz's sub-genus *Solenoporella*) is *Chara* from the Wealden beds of Sussex, the uppermost Jurassic of the Isle of Wight and Swanage, and the Oligocene of the Isle of Wight.

Outside this country the literature on fossil Calcareous Algæ is much more extensive. The interest originally aroused on the Continent by the writings of Philippi, of Unger of Vienna, Cohn, Rosanoff, Gümbel, Saporta, and Munier-Chalmas, has been further maintained in our own time by Bornemann, Steinmann, Früh, Solms-Laubach,[1] Rothpletz, Walther, Kiaer, and others; while the more favourable conditions which obtained for the growth of these organisms, especially during Silurian, Triassic, and Tertiary times, has afforded a much wider field for their observation.

Thus, in addition to the forms recorded from this country, an important part has been played by members of the family of the Dasycladaceæ, together with such genera as *Spherocodium*, *Lithothamnion*, and *Lithophyllum*.

(*To be continued in our next Number.*)

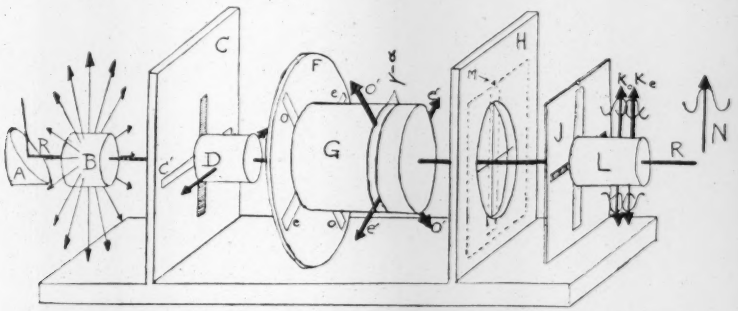
[1] *Fossil Botany* (Oxford), 1891.

VI.—A Model for a Polarizing Microscope.

By W. N. Benson, B.A., B.Sc., Emmanuel College, Cambridge.

PROBABLY most teachers of petrology have experienced difficulty in making clear to some elementary students the manner in which light is transmitted through a polarizing microscope, and the explanation of birefringence and pleochroism. In such circumstances I have found very helpful the analogies illustrated by an easily constructed model. Doubtless such an instrument has been used before, but, as the textbooks make no mention of it, a description may be of use here.

It consists of a number of portions strung on a stout wire or knitting-needle (*R R* in figure), which represents the path of the pencil of rays along the axis of the microscope. The rays falling on the mirror *A* (a cork) are reflected along *R R*, and the pencil is made up of rays vibrating across *R R* in every azimuth (as shown by *B*).



R R, path of ray through microscope axis (lenses not represented); the arrows indicate the planes of vibration; *A*, sub-stage mirror; *C*, polarizer; *D*, plane polarized light; *F*, crystal plate; *H*, cross-wires; *J*, analyser; *Ko Ke*, interference of vibrations brought into the same plane by the analyser (birefringence).

On reaching *C*, the polarizer, each of these rays is resolved into two directions, but is transmitted along one only of these directions (through the slot *C'*). Thus all the light leaving the polarizer vibrates in one plane, as shown by the arrow through the cork *D*, which is rigidly connected with *C*. *F*, representing the crystal plate, rotates freely about *R R*. The light from the polarizer is resolved into two directions perpendicular to each other, and is transmitted through the crystal as through the slots *o* and *e*. In this passage, however, one ray is retarded more than the other, so that the nature of the light as it leaves the crystal plate is illustrated by the two arrows *o'* and *e'* driven through the cork *G*, which is rigidly connected to *F*. As the crystal is rotated the intensity of the *o* and *e* rays vary, and this may be indicated by pushing the corresponding arrows in or out of the cork *G*. The board *H* shows the position of the cross-wires in the microscope, and serves to hold *R R* in place. The analyser *J*, and vibration arrows *Ko* and *Ke* are attached to the cork *L*, which slides on or off *R R*. When properly in position for

the 'crossed nicols' condition the analyser is held in place against *H* by the small stop *M*. The *o'* and *e'* rays from the crystal on entering the analyser are resolved into two components, and of these only one is transmitted. The light leaving the analyser is therefore made up of the resolved portions of *o'* and *e'*, and is indicated by the arrows *Ko* and *Ke*, both lying in the same plane, but one behind the other.

The way for the more rigid explanation of the birefringence colours is often made easy by some such phrase as the following: "The two resolved portions of the polarized ray enter the crystal plate perfectly 'in step', but as one is retarded more than the other while passing through the crystal, it falls behind, and when brought by the analyser into the same plane the two rays are found to be no longer 'in step', and consequently interfere with each other." The interference can be illustrated by soldering to each arrow a portion of a sine curve wire (as at *N*). By varying the distance between the arrows the quartz wedge and kindred phenomena can be well shown.

If a large cork be used for *L*, and the amplitudes of *Ko* and *Ke* be varied as with *o'* and *e'*, one can illustrate the impossibility of obtaining complete extinction with uncrossed nicols.

Pleochroism is exemplified by removing the analyser and clipping differently coloured glass plates (e.g. brown and green) over the *o* and *e* slots in the crystal plate *F*. The *o'* and *e'* arrows may be coloured accordingly, and the variation of the tint as the crystal is rotated is brought out well by varying the lengths of the *o'* and *e'* arrows as before, to give the two colour intensities in all positions. A little mechanical contrivance may be added to do this automatically, but would require nice workmanship.

The model may be used to illustrate several other points, but its application to these ends will occur to every teacher, and need not be mentioned here.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science, Eighty-third Annual Meeting, held at Birmingham, September 10-17, 1913. List of Titles of Papers read in Section C (Geology) and in other Sections bearing upon Geology.

Presidential Address by *Professor E. J. Garwood, M.A., V.P.G.S.* (see ante, p. 440).

Professor Charles Lapworth, F.R.S.—On the Geology of the Country round Birmingham.

Professor W. W. Watts, F.R.S.—Notes on the Igneous Rocks of the Birmingham District.

Mr. George Barrow.—The *Spirorbis* Limestones of North Warwickshire (see p. 463).

Mr. Henry Kay.—On the Stream-courses of the Black Country Plateau (see p. 457).

Professor W. J. Sollas, F.R.S.—On the Formation of Rostro-Carinate Flints.

Mr. E. A. Walford.—On the Structure of the Lias Ironstone of South Warwickshire and Oxfordshire (see p. 460).

Mr. T. C. Cantrill.—*Estheria* in the Bunter of South Staffordshire.

Mr. Leonard J. Wills & Mr. W. Campbell-Smith.—Notes on the Flora and Fauna of the Upper Keuper Sandstones of Warwickshire and Worcestershire (see p. 461).

Professor W. G. Fearnsides.—Nodules from the Basal Ordovician Conglomerate at Bryn Glas, Ffestiniog.

Dr. A. Vaughan.—The Division between the Lower and Upper Avonian.

Mr. F. G. Meachem.—On the Progress of the Coal-mining Industry of the South Midlands since the year 1886.

Dr. E. A. Newell Arber.—The Fossil Floras of the South Staffordshire Coal-field (see p. 462).

Mr. R. D. Vernon.—Correlation of Leicestershire Coal-field (p. 456).

Mr. George Barrow.—On Systems of Folding in the Palæozoic and Newer Rocks (see p. 463).

Dr. A. Irving.—The Harlow Boulder-clay and its place in the Glacial Sequence of Eastern England.

Mr. W. W. King & Mr. W. J. Lewis.—On the Discovery of Lower Carboniferous Grits at Lye, in South Staffordshire.

Mr. E. A. Walford.—The Basement Beds of the Great Oolite, the Crinoid Beds, and the place of *Rhynchonella concinna* in the Oolite Series (see p. 459).

Mr. A. R. Horwood.—The Value of a Knowledge of the Rock Soil Distribution of Plants in tracing Geological Boundaries.

Dr. A. H. Cox & Professor O. T. Jones.—The Geology of the District between Abereiddy Bay and Pencaer, Pembrokeshire (see p. 465).

Dr. Gertrude L. Elles.—The Relation of the Bala and Rhiwlas Limestones in the Bala District.

Mr. E. S. Cobbold.—Critical Sections of the Cambrian area called 'The Cwms' in the Caradoc–Comley region of Shropshire.

Dr. A. Irving.—Flint and its Genesis.

Dr. Marie C. Stopes.—Plant Petrifications in Chert and their Bearing on the Origin of Freshwater Cherts.

Dr. Vaughan Cornish.—On the Conditions which govern the Transport and Accumulation of Detritus by Wind and Water (see p. 455).

Dr. Gertrude L. Elles.—On Shelly and Graptolitic Faunas of the British Ordovician.

Miss Clara E. Sylvester.—A first Revision of the British Ordovician Brachiopoda.

Dr. L. Moysey.—Some further Notes on *Palæoxyris* and other allied Fossils, with special reference to some new features found in *Vetacapsula* (see p. 453).

Mr. Frank Raw.—On Sand-worn Rocks at Lilleshall.

Mr. V. C. Illing.—Recent Discoveries in the Stockingford Shales, near Nuneaton (see p. 452).

Mr. V. C. Illing.—Notes on certain Trilobites found in the Stockingford Shales (see p. 452).

Mr. W. D. Matthew.—Discoveries in the American Eocene.

Dr. H. Warth.—Classification of Igneous Rocks.

Mr. C. Carus-Wilson.—Copper in the Sandstones of Exmouth.
Dr. A. H. Cox & Professor O. T. Jones.—On various occurrences of Pillow-lavas in North and South Wales.
Dr. A. H. Cox.—Note on the Igneous Rocks of Ordovician Age.
Professor W. S. Boulton.—On a new form of Rock-cutting Machine.
Mr. C. H. Cunnington.—The Carboniferous Limestone at the Head of the Vale of Neath, South Wales.
Report of the Committee on Erratic Blocks of the British Isles.
Report of the Committee on the Investigation of the Igneous and Associated Rocks of Glensaul and Lough Nafooey Areas, Co. Galway.
Report of the Committee on preparing a List of Characteristic Fossils.
Report of the Committee on the further Exploration of the Upper Old Red Sandstone of Dura Den.
Report of the Committee on the Geology of Ramsey Island, Pembrokeshire.
Report of the Committee on the Old Red Sandstone Rocks of Kiltorcan, Ireland.
Report of the Committee on the Collection, Preservation, and Systematic Registration of Photographs of Geological Interest.
Report of the Committee to investigate the Microscopical and Chemical Composition of Charnwood Rocks.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Rev. A. L. Cortie, S.J.—Solar and Terrestrial Magnetic Disturbances.
Rev. H. V. Gill, S.J.—The Distribution of Earthquakes in Space and Time.
Mr. J. J. Shaw.—Exhibition of a Seismograph.

SECTION B.—CHEMISTRY.

Professor W. M. Thornton.—The Influence of the Pressure of Gas on the Inflammability of Coal-dust in Air.
Dr. R. V. Wheeler.—The Composition of Coal.

SECTION D.—ZOOLOGY.

Presidential Address by *Dr. H. F. Gadow, F.R.S.*
Professor J. Versluys.—The Carapace of the *Chelonia*.
Professor W. K. Gregory.—Exhibition of a Fossil Skeleton of *Notharctus* sp., an American Eocene Lemur, with remarks on the Phylogeny of the Primates.
Dr. R. Broom—A Mammal-like Milk Dentition in a Cynodont Reptile.
Mr. C. Forster Cooper.—*Thaumastotherium osborni*, a new Genus of *Perissodactyles* presenting some unusual features.
Mr. D. M. S. Watson.—The early Evolution of the *Amphibia*.
Rev. Dr. A. Irving.—The Solutré type of Horse (*Equus robustus*) in Prehistoric Britain.
Professor R. J. Anderson.—On the Skull and Teeth of *Tarsiops*.
Professor R. J. Anderson.—Some Points concerning the Extremities, chiefly in the Mammalia.

SECTION E.—GEOGRAPHY.

Presidential Address by *Professor H. N. Dickson, D.Sc.*
Dr. C. A. Hill.—The Exploration of Gaping Ghyll, Yorkshire.
Professor W. W. Watts, F.R.S.—Notes on the Geography of Shropshire.

Professor J. W. Gregory, F.R.S.—On Australia.
Miss C. A. Simpson.—The Upper Basin of the Warwick Avon.
Mr. A. G. Ogilvie.—The Physical Geography of the Entrance to Inverness Firth.

SECTION G.—ENGINEERING.

Dr. Vaughan Cornish.—On Land Slides accompanied by Upheaval in the Culebra Cutting of the Panama Canal.
Mr. E. R. Matthews.—Harbour Projections and their Effect upon the Travel of Sand and Shingle.
Dr. J. S. Owens.—The Transport and Settlement of Sand in Water, and a method of exploring Sand Bars.

SECTION H.—ANTHROPOLOGY.

Dr. R. R. Marett.—Recent Archæological Discoveries in the Channel Islands.
Mr. W. Dale.—On present Speculations concerning the Age of certain forms of the so-called Neolithic Celt.
The Evolution of Man from the Ape—
(*a*) *Professor Carveth Reed.*—On the Differentiation of Man from the Anthropoids.
(*b*) *Dr. Harry Campbell.*—The Factors Determining the Evolution of Man from the Ape.
(*c*) *Dr. L. Robinson.*—The Relations of the Lower Jaw to Articulate Speech.
Dr. Capitan.—Recent Discoveries of Paintings in the Palæolithic Caves of the South of France.
Mr. T. C. Cantrill.—Stone Boiling in the British Isles.
Dr. T. J. Jehu & Mr. A. J. B. Wace.—Excavations in the Kinkell Cave, St. Andrews.
Mr. H. J. E. Peake.—The early Bronze Age in the Lower Rhone Valley.
Mr. O. G. S. Crawford.—Trade between England and France in the Neolithic and Bronze Ages.
Rev. F. Smith.—Palæolithic 'Guillotine' Trap-stones.
Rev. Dr. A. Irving.—Prehistoric Horse Remains in the Stort Valley.

SECTION K.—BOTANY.

Professor E. C. Jeffrey & Dr. D. H. Scott, F.R.S.—Devonian Plants showing Structure.
Mr. H. Hamshaw Thomas.—On a new type of Ginkgoalian Leaf.
Dr. E. de Fraine.—A new species of *Medullosa* from the Lower Coal-measures.
Professor F. W. Oliver, F.R.S.—On the Distribution of *Sueda fruticosa* and its role in the stabilizing of active Shingle.
Mr. P. H. Allen.—A Botanical Survey of Maritime Plant Formations of Hunstanton, Norfolk.
Mr. A. R. Horwood.—The influence of River Development on Plant Distribution.
Miss W. H. Wortham.—Some Features of the Sand-dunes in the south-west corner of Anglesey.

SECTION M.—AGRICULTURE.

Mr. J. Parry.—The Afforestation of Watersheds.

II.—*Abstracts of Papers read in Section C (Geology), Meeting of British Association, Birmingham, September 10–17, 1913.*

(1) Notes on certain Trilobites found in the Stockingford Shales. By V. C. Illing, B.A., F.G.S.

AMONG the fossils found at Hartshill Hayes, in the Abbey Shale subdivision of the Stockingford Shales, numerous forms occur, representing young stages in the development of certain Trilobite genera. Among these are the following:—

1. *Liostracus* sp.—The development is similar to that of *Liostracus* as described by G. F. Matthew.

2. *Holocephalina* sp.—The early stages of this genus possess a well-marked glabella, widening anteriorly. This becomes less convex in later stages, its anterior margin disappears, and finally the glabella is only represented by two short posterior grooves.

3. *Paradoxides Hicksii*.—The development is similar to that of *Paradoxides* as described by G. F. Matthew.

4. Certain new forms of *Agnostus*.—The anterior portion of the glabella becomes obliterated in the later stages, while the axis of the tail becomes relatively larger with increased development.

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(2) Recent Discoveries in the Stockingford Shales near Nuneaton. By V. C. Illing, B.A., F.G.S.

DURING recent mapping of the subdivisions of the Stockingford Shales between Nuneaton and Merevale, fossils have been found at various horizons which indicate that the Cambrian succession in this area is almost, if not quite, complete. Among these fossil-bearing horizons are the following:—

1. *Lower Purley Shales*.—Shales from a surface working 200 yards south of Worthington Farm, near Hartshill, contain fragments of *Olenellus*. The fossiliferous beds are 40 feet above the base of Purley Shales.

Mr. Pringle, of the Geological Survey, has found *Olenellus* in nodules at the base of the Purley Shales in Jee's Sett Quarry (Summary of Progress, 1913).

2. *Lower Oldbury Shales*.—(*a*) Excavations in Hartshill Hayes have proved that the basal 90 feet of the Oldbury Shales are of Menevian age. They contain the zones of *Paradoxides Davidis* and *P. Hicksii* in their upper and middle beds, while the lower beds contain *Agnostus atavus*, and correspond with Tullberg's *Ag. atavus* zone, and with part at least of the Lower Menevian of Sweden. The Trilobite fauna includes the genera *Paradoxides*, *Anopolenus*, *Conocoryphe*, *Holocephalina*, *Liostracus*, *Microdiscus*, and *Agnostus*, no less than fifteen species of the last genus having been found. At the top of the series there occurs a calcareous conglomerate, containing fragments of the underlying type of shale and indicating a probable unconformity.

(*b*) In a new cutting near Oldbury Reservoir *Olenus truncatus* and *Ag. pisiformis*, var. *obesus*, occur, proving that these beds are of Upper Maentwrog age.

Between the Maentwrog and Dolgelly horizons a series of curly bedded flagstones have been detected. These are very similar to the Ffestiniog Flags, and their position would seem to indicate that they are of Ffestiniog age. The beds are badly exposed and have yielded no fossils up to the present.

Thus the Oldbury Shales represent a large proportion of the Cambrian succession, and in view of this fact, and also of their extreme thickness (2,000 feet), I propose a further subdivision of this group, the classification of the whole succession being as follows :—

Merevale Shales		Lower Tremadoc.
Oldbury Shales	4. Monks Park Shales	Dolgelly.
	3. Moor Wood Flags and Shales	Ffestiniog.
	2. Outwoods Shales	Maentwrog.
	1. Abbey Shales	Menevian.
Purley Shales	Upper, Mid, Lower	Menevian (?).
Hartshill Quartzite	Camp Hill Grit, Tuttle Hill Quartzite, Park Hill Quartzite	Taconian.

(3) Some further Notes on *Palæoxyris* and other allied Fossils, with special reference to some new features found in *Vetacapsula*. By L. Moysey, B.A., M.B., F.G.S.

SINCE the publication of a paper on *Palæoxyris* and other allied organisms in 1910[1] so many fresh specimens have come to hand, and, as was only natural, several previously unrecorded examples have been described, notably some from the Lancashire Coal-measures by Mr. J. Wilfred Jackson,[2] that it seems desirable to record any new features that have been found in the later material, and also any new facts that may lead to the elucidation of the nature of these still very enigmatical organisms.

Taking in the first instance the genus *Palæoxyris*. The species *Palæoxyris helicteroides* (Morris) has been lately found in very large quantities in the Notts and Derbyshire Coal-field. In this area they seem to be restricted to an horizon extending from the roof of the Top Hard Coal downwards to above the Ell Coal; a careful search in the measures below, wherever these are exposed, has not resulted in the discovery of any trace of this fossil. They were, some years ago,[3] discovered in great numbers in the open working of the Barnsley thick coal at Worsborough, near Barnsley, where some 300 odd specimens were collected by Mr. W. Gelder from a space 6 or 7 yards in circumference, together with some specimens of *P. prendeli* (Lesq.) and *P. carbonaria* (Schimper).

A hurried search in other claypits at horizons above and below this coal during the Sheffield meeting of the British Association in 1910 produced enough specimens to make it probable that, if looked for, they may prove to be similarly quite common fossils in the great

[1] L. Moysey, Quart. Journ. Geol. Soc., vol. lxvi, pp. 329–45, pls. xxiv–vii, 1910.

[2] J. Wilfred Jackson, *Lancashire Naturalist*, January, 1911.

[3] R. Kidston, *Naturalist*, 1897.

II.—*Abstracts of Papers read in Section C (Geology), Meeting of British Association, Birmingham, September 10–17, 1913.*

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(2) Recent Discoveries in the Stockingford Shales near Nuneaton. By V. C. Illing, B.A., F.G.S.

DURING recent mapping of the subdivisions of the Stockingford Shales between Nuneaton and Merevale, fossils have been found at various horizons which indicate that the Cambrian succession in this area is almost, if not quite, complete. Among these fossil-bearing horizons are the following:—

1. *Lower Purley Shales*.—Shales from a surface working 200 yards south of Worthington Farm, near Hartshill, contain fragments of *Olenellus*. The fossiliferous beds are 40 feet above the base of Purley Shales.

Mr. Pringle, of the Geological Survey, has found *Olenellus* in nodules at the base of the Purley Shales in Jee's Sett Quarry (Summary of Progress, 1913).

2. *Lower Oldbury Shales*.—(*a*) Excavations in Hartshill Hayes have proved that the basal 90 feet of the Oldbury Shales are of Menevian age. They contain the zones of *Paradoxides Davidis* and *P. Hicksii* in their upper and middle beds, while the lower beds contain *Agnostus atavus*, and correspond with Tullberg's *Ag. atavus* zone, and with part at least of the Lower Menevian of Sweden. The Trilobite fauna includes the genera *Paradoxides*, *Anopolenus*, *Conocoryphe*, *Holocephalina*, *Liostracus*, *Microdiscus*, and *Agnostus*, no less than fifteen species of the last genus having been found. At the top of the series there occurs a calcareous conglomerate, containing fragments of the underlying type of shale and indicating a probable unconformity.

(*b*) In a new cutting near Oldbury Reservoir *Olenus truncatus* and *Ag. pisiformis*, var. *obesus*, occur, proving that these beds are of Upper Maentwrog age.

Between the Maentwrog and Dolgelly horizons a series of curly bedded flagstones have been detected. These are very similar to the Ffestiniog Flags, and their position would seem to indicate that they are of Ffestiniog age. The beds are badly exposed and have yielded no fossils up to the present.

Thus the Oldbury Shales represent a large proportion of the Cambrian succession, and in view of this fact, and also of their extreme thickness (2,000 feet), I propose a further subdivision of this group, the classification of the whole succession being as follows :—

Merevale Shales		Lower Tremadoc.
Oldbury Shales	4. Monks Park Shales	Dolgelly.
	3. Moor Wood Flags and Shales	Ffestiniog.
	2. Outwoods Shales	Maentwrog.
	1. Abbey Shales	Menevian.
Purley Shales	Upper	Menevian (?).
	Mid	
	Lower	
Hartshill Quartzite	Camp Hill Grit	Taconian.
	Tuttle Hill Quartzite	
	Park Hill Quartzite	

(3) Some further Notes on *Palæoxyris* and other allied Fossils, with special reference to some new features found in *Vetacapsula*. By L. Moysey, B.A., M.B., F.G.S.

SINCE the publication of a paper on *Palæoxyris* and other allied organisms in 1910[1] so many fresh specimens have come to hand, and, as was only natural, several previously unrecorded examples have been described, notably some from the Lancashire Coal-measures by Mr. J. Wilfred Jackson,[2] that it seems desirable to record any new features that have been found in the later material, and also any new facts that may lead to the elucidation of the nature of these still very enigmatical organisms.

Taking in the first instance the genus *Palæoxyris*. The species *Palæoxyris helicteroides* (Morris) has been lately found in very large quantities in the Notts and Derbyshire Coal-field. In this area they seem to be restricted to an horizon extending from the roof of the Top Hard Coal downwards to above the Ell Coal; a careful search in the measures below, wherever these are exposed, has not resulted in the discovery of any trace of this fossil. They were, some years ago,[3] discovered in great numbers in the open working of the Barnsley thick coal at Worsborough, near Barnsley, where some 300 odd specimens were collected by Mr. W. Gelder from a space 6 or 7 yards in circumference, together with some specimens of *P. prendeli* (Lesq.) and *P. carbonaria* (Schimper).

A hurried search in other claypits at horizons above and below this coal during the Sheffield meeting of the British Association in 1910 produced enough specimens to make it probable that, if looked for, they may prove to be similarly quite common fossils in the great

[1] L. Moysey, Quart. Journ. Geol. Soc., vol. lxvi, pp. 329–45, pls. xxiv–vii, 1910.

[2] J. Wilfred Jackson, *Lancashire Naturalist*, January, 1911.

[3] R. Kidston, *Naturalist*, 1897.

coal-field of which the Notts and Derbyshire area is merely an extension.

In fact, it seems probable that the habit of collectors to look for fossils only in the Coal-measure shales, to the neglect of the ironstone nodules, may account for the paucity of specimens found in other coal-fields.

The other species, *Palæoxyris carbonaria* (Schimper) and *Palæoxyris prendeli* (Lesq.), seem, on the contrary, to be extremely rare in this area, and, when found, they are usually associated with quantities of *P. helicteroides*.

Vetacapsula cooperi (Machie & Crocker)[1] must still lay claim to being an extremely rare fossil. This genus is not restricted to a definite horizon in Derbyshire and Notts Coal-fields, but has been found to range from between the Waterloo and Ell Coals at Newthorpe Claypit, downwards to the Kilburn Coal at Loscoe Colliery. Three new specimens have been obtained—two from the Silkstone Coal and one from the Kilburn Coal. One of these, a specimen from the Silkstone Coal of the Calow Colliery, Chesterfield, shows a feature of great interest. When first found the fossil presented the appearance of a very much crushed example; but careful development revealed the fact that the fossil was, in reality, a perfectly normal flattened specimen, and the feature that gave rise to the apparent deformity was the presence of a medial, longitudinal flange, or fin-like structure, which extends along the 'median raphæ', emphasized by the original describer of the genus, dismissed in my former paper as possibly due to crumpling, and again brought into prominence by Mr. J. Wilfred Jackson. It seems now that this 'median raphæ', which appears to be a constant feature in every specimen recorded, may be caused in the ordinary specimens by this flange being torn off, and being left embedded in the matrix of the counterpart. It is also instructive to compare this new-found flange with that described by Mr. Bashford Dean on the egg-case of *Chimæra collei*.

From the examination of the four specimens in the author's collection and others elsewhere it is becoming more apparent that there are two distinct species included under the name of *Vetacapsula cooperi*. Owing, however, to the at present uncertainty as to their affinities, and to the rarity of their occurrence, it seems best still to keep them under one trivial name and separate them by applying the designation 'forma *a*' to those specimens in which the pedicle expands suddenly into the body, forming a distinct shoulder in the lower third of the body and giving rise to a 'deformity' or crumpling in that region; and the designation 'forma β' to those in which the pedicle expands more gradually into the body, giving to the specimen an ovate contour, with the 'deformity' or crumpling in the centre.

A curious and interesting feature is seen on the outer edge of all specimens conforming to 'forma β'. Just before the body contracts to form the beak there is found, by examination with the ordinary lens, a minute crenulation or crimping of the edge of the fossil, which may be compared with the markedly rugose lateral webs seen on the egg-cases of *Chimæra collei*, *Rhinochimæra*, and other Chimæroids.

[1] E. J. Machie, *Geol. and Nat. Hist. Repertory*, vol. i, pp. 79–80, 1865–7.

One fresh specimen of *Vetacapsula johnsoni* (Kidston) has come under notice from the Worsborough open works near Barnsley. It is in too crushed and imperfect condition to show any new features.

A new species of *Vetacapsula* has been recently described by Mr. Good[1] from Pembrokeshire. It is very similar to *Vetacapsula johnsoni*, but is extremely small, measuring only 5 mm. across, whereas *Vetacapsula johnsoni* measures 20 mm.

A new specimen of *Fayolia crenulata* (Moysey) has been discovered lately from a small heap of nodules still remaining from the Shipley Claypit. The former example from Shipley consisted of the middle portion of the organism 11 cm. long; another specimen, doubtfully referred to *Fayolia sterzliana* (Weiss), from the same locality, was evidently nearing its proximal or pedicular termination. The new specimen is of interest mainly because it shows the apex or distal termination, which appears to have been dome-shaped. The chief feature is the marked exaggeration of the crenulate 'collerette' which arises from the junction of the two spiral valves, and which forms a sort of spiral 'corona' round the apex of the fossil, strongly reminiscent of the corona at the summit of the egg-case of *Cestracion philippi*.

(4) On the Conditions which govern the Transport and Accumulation of Detritus by Wind and Water. By Vaughan Cornish, D.Sc., F.R.G.S., F.G.S., F.C.S.

THE author dealt with the conditions of the transport of detritus superficially and in suspension. He pointed out that the rate of subsidence is the constant which best defines the behaviour of a granular material with respect to transportation by currents. He showed how detritus may be classified in three groups according to the value of this constant, these groups being familiar as shingle, sand, and mud, in the case of water-borne material, and gravel, sand, and dust in the case of wind-borne detritus.

It was pointed out that the change of direction of the vertical currents in sea-waves does not occur simultaneously with the change of direction of the horizontal currents, and it was shown that the result of the sequence of the changes is to endow waves with a shoreward action upon shingle and the coarser kinds of sands independently of any motion of translation in the water.

In tides also, rise does not commence simultaneously with flow, nor fall with ebb, and the author showed that the sequence of these changes is such as to make the flood tide more effective than the ebb as an agent of littoral drift, apart from any greater speed of current.

Examples were given of the different positions in which deposits of detritus accumulate according to the rate of subsidence of the particles.

An explanation was given of the effect of a change in the inclination of current to the horizontal in sorting heterogeneous detritus, and examples were given for wind-borne material.

[1] R. H. Good, Quart. Journ. Geol. Soc., vol. lxix, p. 266, pl. xxx, fig. 3, 1913.

(5) On the Correlation of the Leicestershire Coal-field. By Robert Douglass Vernon, B.A., B.Sc., F.G.S.

THE following is a preliminary account of a study in the correlation of the coal-fields of the eastern portion of the great Midland coal basin. The area in question includes the Derbyshire and Nottinghamshire Coal-field in the north, the Warwickshire Coal-field in the south-west, and the Leicestershire Coal-field, which lies midway between the two. It is with the latter that we are here chiefly concerned. The Carboniferous rocks of Leicestershire include Carboniferous Limestone, Limestone Shales, Grits, and Sandstones that have been referred on lithological evidence to the Millstone Grits, and, lastly, the Coal-measures. Such a sequence at once suggests a correlation with the Derbyshire and Nottinghamshire type, but the presence of unusually thick seams of coal which split towards the north favours a comparison of the Middle Coal-measures of Leicestershire with those of Warwickshire. Finally, in the complete absence of the Transition Series and Upper Coal-measures and the presence of a complex fault system, the Leicestershire Coal-field stands quite apart from either of its neighbours.

For the detailed correlation of the Upper Carboniferous of these tectonic basins we have several independent criteria, both physical and palæontological, but strong theoretical objections may be urged against the use of physical criteria alone, and in practice it was found to be impossible to use either the important sandstones or the seams of coal in the correlation even of the eastern and western portions of the Leicestershire Coal-field itself.

The problem was then attacked from the palæontological side. Fossil plants proved of relatively little value in the subdivision of the Leicestershire sequence, because the lowest and the highest plant-bearing horizons both appear to fall within the Middle Coal-measures. The freshwater lamellibranchiata (*Carbonicola* and its allies) were equally unsatisfactory, so that the work finally resolved itself into a search for Marine Beds and an attempt to lay down their outcrops on the 6 inch maps.

Of the three more or less distinct districts into which the Leicestershire Coal-field may be divided, the Central or Ashby area of so-called unproductive measures yielded no fossils, either plant or animal, and the age of the beds, whether Lower or Middle Coal-measures, remains an open question. The Eastern or Cole Orton area presents serious difficulties to the collector, being for the most part a concealed coal-field worked under a thick Triassic cover, and the results obtained were merely of local interest. Attention was finally concentrated on the western or Moira area, where the sequence is more complete than in the rest of the coal-field, and exposures are much more numerous. Many fossiliferous horizons were discovered, which yielded a rich flora, several rare Crustacea, some fragmentary fish-remains, numerous freshwater lamellibranchiata, and above all an abundant marine fauna from several different horizons and many localities. Unfortunately, no indication of the well-known Gannister Coal Marine Bed (Alton Coal of Nottinghamshire) has yet been found in Leicestershire.

The thickest Marine Bed, which also has the richest fauna, occurs in the higher portion of the Middle Coal-measures about 260 yards above the Moira Main Coal; it crops out at many places in the Moira, Swadlincote, Church-Gresley, and Woodville district, and the outcrop has been laid down on the 6 inch scale.

Such mapping is of value, since for want of an index bed it has hitherto been impossible to map any seam of coal above the Main Coal owing to the variable character of the beds in the higher portion of the Coal-measures, and the structure of this part of the coal-field was, therefore, imperfectly understood. Using this Marine Bed as an index bed, we can now fix the position in the sequence of the Moira Sandstones and Grits and of the valuable series of pot, pipe, and fireclays on which the prosperity of this district so largely depends.

The main interest of this Marine Bed is that in stratigraphical position and in faunal contents it is comparable with the Gin Mine Marine Bed of the North Staffordshire Coal-field, with the Mansfield Marine Bed of the Yorkshire and Nottinghamshire Coal-field, and with the Pennystone Ironstone Marine Bed of Coalbrookdale.

The following is a correlation of the Productive Coal-measures of the East Midland Coal-fields, based upon the chief marine transgressions:—

	Yorkshire and Nottinghamshire Coal-field.	West Leicestershire Coal-field.	Warwickshire Coal-field.	
Middle and Lower Coal-measures.	Mansfield Marine Bed.	Pottery Clay Marine Bed.	Doubtful	Middle Coal-measures.
	Strata, 930 feet.	Strata, 750 feet.	Strata, thickness unknown.	
	Marine Bed 300 feet below the Top Hard coal.	Marine Bed above the Main Coal.	Marine Bed above the 7 foot Coal	
	Strata, 1,600 feet.	Strata, thickness unknown.		
	Marine Bed above the Alton (Ganister) coal.	Doubtful.	Absent.	

In conclusion, it is shown that in colour, mode of weathering, and other characteristics these Marine Beds are in every way comparable with modern 'Blue Muds'.

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(6) On the Stream-courses of the Black Country Plateau. By Henry Kay, F.G.S.

THE Black Country plateau is roughly outlined by the 400 feet contour-line between Stafford, Worcester, Stratford, and Burton, and is identical with the anticline of the South Staffordshire Coal-field, plus the north-western parts of Cannock Chase and the Warley–Barr area eastward. On its eastern and western sides are synclinal valleys opening to the Trent and Severn.

It is surrounded by a marginal hill barrier, and has large hill masses at Cannock Chase and the Clent region; while it is crossed by hill ranges from Bushbury to Barr Beacon, from Wolverhampton to the Lickeys, and from Quinton to Birmingham. The surface is thus divided into four interior basins, forming separate drainage areas. Save for the exits from these basins, the margin is broken in two places only. The chief physical feature is the possession of the crucial portion of the Midland watershed, which runs across the plateau from Wolverhampton to the Lickeys, and thence eastward along the southern margin.

Arterial drainage is supplied by the Trent and Severn, the former draining five-sixths of the plateau, and the latter receiving only the southward marginal drainage and that of the Stour basin.

The eastern syncline is occupied by the River Blythe–Tame flowing north. The watershed at the southern end of this valley has retreated northwards for 4 miles in post-Glacial time.

The western syncline was formerly drained towards the Dee, and the head-waters of the Severn were originally around Kidderminster, the Clent range being united with the Enville Hills further west. The principal outlet towards the Dee was by the Church Eaton Water, and the outlet into the Trent below Stafford not then in existence. This syncline is now drained northward by the Penk into the Sow and Tame, and southward by the Smestow–Stour into the Severn. Stream piracy is manifest near Wolverhampton.

Marginal streams are characterized by excessive activity, especially southward, notable examples being the Arrow and the Alne. The Arrow, however, represents the captured head-waters of an ancient river flowing through the Moreton Gap into the Evenlode, the pirate stream being the Warwickshire Avon, a strike river originally confined to the country west of Evesham. The watershed then ran southward from the Lickeys to the Cotswolds, being now represented by a long, narrow promontory reaching into Evesham and by Bredon Hill southward. Internal drainage is confined to the four basins. The Cannock basin has now no trunk stream, its waters uniting near the exit below Cannock to form the Saredon Brook. Glacial modification is much in evidence, the south-eastern portion having formed a lakelet with gorge-like overflow through Walsall. The margin of this basin has twice been broached by marginal streams. The Tame basin is triangular in shape and formed by the union of two basins reaching back to pre-Triassic ages, a large buried stream-course existing at Moxley, whilst a very great valley is traceable upwards through Smethwick, Oldbury, and Blackheath. At this point two buried stream-courses are found, each filled with material transported from the Clent Hills. The inference is that this marked the original source of the Trent, as the Upper Trent Valley appears to be of more recent date.

The Stour basin is likewise a combination. Streams descend south-west from Dudley to Stourbridge, and north-eastward from Clent to Halesowen. They are united by a succession of gorges 4 miles in length. This basin is a remarkable instance of extreme post-Glacial denudation to a depth of 300 feet. The Halesowen

streams represent the original head-waters of the river once flowing through Blackheath, Oldbury, and Smethwick.

The Rea basin possesses three eastward-flowing streams successively diverted N.N.E. through Birmingham by a stream working back along the Rea fault. Two of these were captured in pre-Glacial time, the third in consequence of glacial lakelet overflow. The present thrice-notched ridge at King's Heath represents the pre-Glacial land surface. The Middle Cole Valley is wholly post-Glacial. The Lickey anticline has undergone elevation since the initiation of the Rea streams—i.e. in post-Tertiary time. It is crossed by three waterworn gaps excavated *pari passu* with this uprise. The southernmost of these now drains into the River Arrow.

The Warley–Barr area is a region of Tertiary uplift, across which rivers occupying the old pre-Triassic valleys have excavated deep channels. All other streams in this area are very youthful.

Conclusions.—The Trent drainage area has been subjected to excessive piracy and has steadily suffered loss. Its sole gain is that of the Penk at the expense of the Dee. The northern drainage is consequent on the formation of the South Staffordshire anticline, regarding the age of which it bears notable evidence. Speculations as to the former north-west extension of the Thames drainage must therefore be abandoned on reaching the area under consideration.

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(7) On some of the Basement Beds of the Great Oolite and the Crinoid Beds. By Edwin A. Walford, F.G.S.

SOWERBY, in vol. i *Mineral Conchology*, describes a Brachiopod now known as *Rhynchonella concinna*. It is figured on T. lxxxiii, 6 from Aynhoe in Northamptonshire. A note on a quarry in the Great Oolite made by the writer in 1883 fixes probably the source of Sowerby's shell—

Aynhoe Allotments Quarry.

	ft.	in.
1. Humus	1	3
2. Whitish Marl	1	3
3. Marl crowded with *Rhynchonella concinna*, *Ostrea Sowerbyi*, *Natica*, *Modiola*, *Pholadomya*	2	6
4. Shelly Limestone, false-bedded	1	9
5. Grey Marl	2	1
6. Limestone, whitish: top course	1	6

The Geological Survey found its stratum to be a convenient line of demarcation, as it rested upon a base of limestone graduating into the Stonesfield Series.

The discovery of other strata on the borders of East Oxfordshire and West Oxfordshire necessitates the division of the Great Oolite and the separation of the new beds proposed to be classed as Sub-Bathonian. The old survey lines are thus sustained. The sequence suggested is as follows:—

Upper Great Oolite.—1. *Terebratula maxillata* beds. 2. *Calcaire à Echinodermes*.

Lower Great Oolite.—1. Striped Limestones. 2. *Rhynchonella concinna* beds. 3. Stonesfield Slate.

Sub-Bathonian.—1. Striped Limestone and Crinoid beds. 2. Neæran Series. 3. Striped Crinoid Marls. 4. Chipping Norton Limestones.

The new railway (Aynhoe and Ashendon) is cut along the divide between the Cherwell and Ouse Rivers. The missing Sub-Bathonian Series of the West lands were brought to view. Prominent there were White Calciferous Limestones and Striped Marls and Limestones. The author found the chalk-like limestone to be crowded with the decayed heads of large crinoids of which it was made. Above it passed into a blue crystalline limestone, here and there; a packed mass of the brachial joints of the crinoids. At the base of all was the stratum of black vertical stripes (the striped beds), the place of crinoid column and rootlets filled with carbonaceous granules from dark beds above. The beds are now known to be marine, not estuarine, as previously described. Sections of the chalk-like limestone showed a pavement of discs of the crinoid (*Apiocrinus*) calyx.

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(8) On the Structure of the Lias Ironstone of South Warwickshire and Oxfordshire. By Edwin A. Walford, F.G.S.

THE ironstone of South Warwickshire and North Oxfordshire is got wholly from the Middle Lias. The Northamptonshire ironstone of the Inferior Oolite may be traced in the Burton Dassett Hills, where it passes into a useless sandstone.

Beds of the Middle Lias stone are seen in the quarries packed with curved and interlacing stems something like masses of annelid tubes. They lie upon the bedding plane. Other beds of the fine pentangular and smaller ossicles of the Crinoidea range between. More rarely the round columnar stems of forms like *Apiocrinus* are found.

The author infers that the sea floor of the Middle Lias was a tangle of crinoid growth, stage above stage. The Crinoid sea appears to have spread through the Midlands into Yorkshire. Occasionally are phases of invasion or dominance of shells of Brachiopoda. Beds of *Rhynchonella tetrahedra* and *Terebratulæ* are interspersed in the 25 feet of the ferro-crinoid rock-bed.

The quarries and sections in the neighbourhood of Banbury show the several phases described.

In the Nodule Bed at the base of the Ironstone Series (zone of *Spirifer oxygona*) crinoidal conditions appear in segments and stem casts, mingled with large mollusca. Microscopic sections present plates and segments of Crinoidea mingled with ferruginous Oolitic grains of large size and fox-brown colour.

The superimposed bed, the Best Rag, has in sections smaller Oolitic grains of olive-green iron carbonate with ovoid calicular plates of crinoids.

The Top Rag, a grey-green compact stone, is a tangle of crinoidal and other remains more or less broken and converted into Oolitic iron granules.

The Road Stone, the higher beds, shows its organic structure mainly destroyed and converted into the ordinary red oxide.

In 1896 I placed a short study on the making of the Middle Lias Ironstone of the Midlands before the Iron and Steel Institute, which appeared in their *Proceedings*.

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(9) Notes on the Flora and Fauna of the Upper Keuper Sandstones of Warwickshire and Worcestershire. By L. J. Wills, M.A., F.G.S., and W. Campbell Smith, M.A., F.G.S.

A GROUP of sandstones associated with green shaly marls have been shown by Dr. C. A. Matley to form a more or less continuous belt in the Keuper Marls in Warwickshire, and to lie about 120 to 160 feet below the Rhætic. At the same horizon similar beds form an almost unbroken outcrop through Ripple, Longdon, Pendock, and Eldersfield in South-West Worcestershire, and were probably once continuous with the sandstones of Inkberrow and Callow Hill, near Redditch.

Of the constituents, the thin-bedded sandstones are fine-grained, ripple-marked, and characterized by the presence of much calcareous matter and abundant rhombs of dolomite. The thicker-bedded sandstones consist mainly of grains of quartz, with felspar and the usual assemblage of heavy minerals in well-rounded grains; of these garnet is the most conspicuous. Close to the base of the group there is frequently a conglomeratic bed ('bone-bed'), composed of fragments of green marl, plants, bones, and teeth. Shales and steinmergel may occur with the sandstones.

We are able to describe for the first time from the English Trias examples of the foliage and scales of the female cone of a *Voltzia*, closely resembling *V. heterophylla*, of the Bunter of the Vosges, and to record new occurrences of *Voltzia*, *Schizoneura*, *Carpolithus*, and, possibly, *Yuccites*.

The plants are associated with indeterminable teeth and bones of Labyrinthodonts, and with fish-remains, which are abundant in the 'bone-bed' and very rare at higher horizons.

Fish-teeth, hitherto described as *Acrodus? keuperinus*, are widely distributed, and prove, on microscopic examination of their internal structure, to be referable to *Polyacrodus* (Jaekel). Dorsal-fin spines and cephalic spines associated with these teeth probably belong to the same genus.

Teeth similar to *Phæbodus brodiei* have been found at Knowle. *Phæbodus*, *Semionotus*, and *Ceratodus* have all been previously described from these beds.

Cestraciont remains allied to *Polyacrodus keuperinus* are especially abundant in 'bone-beds' at the base of the Lettenkohle in Germany, and its presence may be regarded as evidence of estuarine conditions. *Ceratodus*, on the other hand, occurs frequently in the Rhætic, a deposit usually accepted as marine, but its only living ally inhabits some rivers in Queensland.

We have found *Thracia? brodiei* at Shelfield. This lamellibranch was described by Mr. R. B. Newton as a truly marine form, but it is only represented by rather obscure casts.

Estheria minuta, a form that is probably never truly marine, is practically ubiquitous, and occurs in both shales and sandstones.

The fauna and flora is thus seen to be a restricted one, though many specimens have been found, and their testimony on the origin and age of the deposit is inconclusive.

If we may judge from the lithology, the conditions which governed the formation of the 'skerry-belts' of Nottinghamshire and Leicestershire—namely, the arrival of floods of fresh water—probably acted more persistently in the area under consideration, as a result of its greater proximity to land. For not only are the beds very similar to the 'skerries', but in the 'bone-bed' or marl conglomerate we have positive evidence of littoral conditions.

Thus we are not dealing with a pre-Rhætic incursion of the sea, but with a littoral facies of the Keuper Marls, formed where the water was at times sufficiently fresh to support a small fish-fauna and in sufficient motion to move coarse sediments.

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(10) On the Fossil Floras of the South Staffordshire Coal-field. By E. A. Newell Arber, M.A., Sc.D., F.G.S.

THE rich series of floras of the South Staffordshire Coal-field has suffered much unfortunate neglect in the past. Several collections have, it is true, been made from time to time, but with very few exceptions they have never been described, and some of them are without proper records of locality and horizon. For such trustworthy records as exist we are chiefly indebted to Dr. Kidston and to his memoir published as far back as 1888. The number of species, the exact locality and horizon of which are recorded, is at present as follows:—Keele Series 16, Halesowen Sandstone Series 0, ? Brick Clay Series (Old Hill Marls) 8, Productive Measures 27.

For some time past I have been endeavouring to extend our knowledge of the fossil floras of this coal-field, and I have been fortunate in receiving the active co-operation of several geologists resident in Birmingham and the neighbourhood, who have most kindly formed collections from particular areas, and forwarded the specimens to me for examination and description. In this way the material which I have myself been able to collect has been greatly extended. My thanks are in particular due to Mr. H. Kay, F.G.S., Mr. W. H. Foxall, F.R.G.S., Mr. W. H. Hardaker, M.Sc., and Mr. L. Jackson for their enthusiastic co-operation.

Attention has been chiefly concentrated so far on the floras of the Brick Clays, and of the lowest beds of the Productive Measures on or about the horizon of the Bottom Coal. A considerable number of species have been obtained from both horizons, of which some are new records both to the coal-field and to Britain. This work is still in progress. Information has also been obtained as to the horizon and localities in which the petrified specimens, long known from this coal-field, occur, such information having been lost for many years past.

In addition the first fossil plants from the Halesowen Sandstone Series have been unearthed by Mr. Kay, and here again both petrifactions and impressions occur.

It is hoped that in course of time it will be possible to trace the floras systematically from the lowest to the highest beds of the Coal-measures of this coal-field. The material, however, has to be obtained as opportunity offers, and this preliminary note is intended merely to indicate the present progress of the work.

(11) On Systems of Folding in the Palæozoic and Newer Rocks. By G. Barrow, F.G.S.

IN a paper published by the Geologists' Association the author has given a brief outline of the nature of the crystalline area of the Highlands and shown that it consists of three great lenticular masses of thermally altered rocks. It is further shown that the outer and uncrystalline margins of these masses all trend roughly north-east and south-west. The best known is that forming the south-eastern margin of the crystalline area, which the author has followed, where present at the surface, almost the whole distance from Stonehaven, on the east coast of Scotland, to Omagh in the north of Ireland. Recent work suggests that this margin is also present on the west coast of Ireland.

This outer margin of crystallization is not confined to Scotland; it is also present in Anglesea, where the margin of the crystalline massif is seen along a portion of the Menai Straits. It also occurs in the Isle of Man, where the old rocks are identical with those of the lower aureoles of thermometamorphism in the Southern Highlands. In both cases the trend of this outer margin is the same—north-east and south-west. Wherever this margin can be examined it has been found to be a great line of resistance, and the folding in the adjacent palæozoic, and, at times, even newer rocks, is found to be parallel to it; it is in fact the cause of the strike of the folding; under earth-stresses the softer rocks have buckled up against a great resisting crystalline mass.

Thus, strictly speaking, there is no such thing as a Caledonian Movement; there are a series of resisting masses with parallel margins; the folding in North Wales is determined by the Anglesea Archæan Rocks; Caledonia has nothing whatever to do with it.

If, now, we turn to the area in the south of Britain, we find another system of folding; this, too, the author believes to be due to a similar cause. The outer margin of the old crystalline rocks in Cornwall seems to be roughly east and west; it certainly is not north-east and south-west. It now remains to do in the north-west of France what the author has done in North Britain—i.e. to trace out the outer margins of crystallization and prove that the so-called Hercynian system means simply that the boundaries of the resisting crystalline masses, against which the newer rocks buckle up, now trend east and west. If these facts are once grasped we have an explanation of the local departure of the strike of the folding in the north of England; the lines of resistance locally depart from their usual trend and the subsequent folding does the same.

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(12) On the Spirorbis Limestones of North Warwickshire. By G. Barrow, F.G.S.

THE typical Spirorbis limestone is a rather compact rock, usually grey and generally containing the small fossil *Spirorbis carbonarius*. The number of these varies greatly; at times several specimens may be seen in one fragment; often it is difficult to find any, and, so far as experience has gone at present, they are never

abundant in this area. Though the dominant colour is grey, the rock is often buff and occasionally almost white.

The purest form of Spirorbis limestone occurs in masses of very variable size. The largest and most persistent bed is the Index limestone, which occurs roughly about 100 feet down in the Halesowen or Newcastle Group. This has often been confused with another and less persistent bed, lying about 100 feet further up and close to the base of the Keele Group. Other and less persistent bands have been met with in the Keele Group, notably by Mr. Cantrill. In addition to these distinct beds, which can often be traced for some distance at the outcrop, if the ground be free of drift, there are lenticles varying in length from a few yards to a few inches, and at times only scattered nodules. These smaller patches were found during the great drought, when the old marl pits in the Halesowen Group were completely dried up. Advantage was taken of this to clean the pits out, laying the rock sides bare, when these minor occurrences of the limestones were exposed.

The limestones seem to have been built up of a series of films or layers, resulting from the evaporation of shallow sheets of lime-bearing water. When dried the film appears to have been cracked and more or less broken up, but re-cemented by later deposits of identical material; this in turn became broken up and re-cemented. The process was repeated till a bed several feet thick was at last accumulated. The whole rock thus comes to have a clean sharp fracture, though its fragmental character is easily seen on a freshly fractured face. In this form, best shown by the Index limestone, there is a minimum of material other than lime brought into the deposit. A rough test of the brecciated original fragments shows the limestone to be nearly pure and containing about 95 per cent of carbonate of lime.

From this we pass to the type containing small fragments of other material, such as marl, and the cementing matrix is not merely calcite, a considerable proportion of mud and sand being present. In this the limestone fragments are somewhat rounded, having been transported for short distances. At times the fragments are locally heaped up and the bed attains a quite abnormal thickness. The band at or near the base of the Keele Group shows this character in the cutting of the mineral railway above Kingsbury; the fragments have been heaped up till it has locally attained a thickness of 10 feet.

The extreme type is really a cornstone, or a sandstone more or less crowded with rolled fragments of Spirorbis limestone. It is doubtful in this case if any of the rounded fragments are formed in situ; the whole rock seems to have been the result of flood action tearing up a deposit cracked by drying and transporting the fragments for some distance.

There is strong evidence to support the view that two at least of these limestones were formed over a large area; the Index has rarely been removed completely by this process; the one next above often has. How far the less persistent beds have been locally removed by subsequent erosion is at present an open question.

This mode of origin of the more impure, possibly of all the

limestones, is supported by the character of the sandstones. These at their base often contain abundant pellets of marl, which from their form appear to have been sun-dried and so rendered sufficiently coherent to be capable of transportation for short distances without losing their cuboidal form. The phenomena suggest formation in shallow water, during a dry epoch, subject to sudden or periodical floods.

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(13) The Geology of the District between Abereiddy and Pencaer, Pembrokeshire. By A. Hubert Cox, M.Sc., Ph.D., F.G.S., and Professor O. T. Jones, M.A., D.Sc., F.G.S.

In an introductory paragraph the authors referred to the work of previous observers, namely, Hicks, Reed, Elles, and Elsden, and to the visit of the Geologists' Association during Easter, 1910, when results were obtained which suggested that this area required re-investigation. Examination by the authors has proved that the apparent sequence is extremely complicated by strike-faulting, and instead of Llandeilo and Bala rocks as previously supposed, Arenig and even Cambrian rocks form large areas of the coast.

Part I. Abereiddy Bay to Pwll Strodyr (A. H. Cox).

The ground is occupied by the under-mentioned beds, the stratigraphical order of which is, so far as known, as follows:—

Bala	Limestone of Eastern Quarry, Abereiddy = Mydrim Limestone of Carmarthenshire.
Llandeilo	Lower Dicranograptus Shales = Hendre Shales of Carmarthenshire.
Llanvirn	Didymograptus Murchisoni Shales. Didymograptus Murchisoni Volcanics (including the Abereiddy Ash, and Llanrian lavas). Didymograptus bifidus Shales.
Arenig	Tetragraptus Beds—dark slates. Porth Gain Beds—grits and slates with *Orthis calligramma*, var. *proava*. Abercastle Beds—sandy mudstones with *Ogygia selwyni*, etc.
	? gap.
Doubtful Age	Castell Coch Beds—cleaved blue-black mudstones. Ynys Castell Beds—siliceous mudstones and cherts. Ynys Castell grit and breccia.
	? break.
Lingula Flags	Flags and laminated quartzites with *Lingulella davisii*.
Doubtful Menevian.	Slates near Abercastle with *Agnostus* sp.

The 'Middle Llandeilo' of Hicks' classification has been found to include the Lower Dicranograptus Shales and the succeeding limestone; that is, actually more than the Llandeilo formation as now defined. The 'Upper Llandeilo' includes various Lower Llanvirn and Arenig beds; the affinities of the other rock-groups are briefly discussed in the paper. Lingula flags occupy much of the adjoining inland district.

References are made to certain "intrusive rocks and their relation to the adjoining sediments". The detailed mapping of the area is now in progress.

Part II. Pwll Strodyr to Pencaer (O. T. Jones).

The following rock-groups are represented in probable descending order :—

Lower or Middle Arenig	Pwll Deri Slates . . .	Cleaved dark slates with extensiform graptolites.
? Lower Arenig . .	Aberbach Quartzite Group probably equivalent to the quartzites of Trwyn Llwyd and possibly of Pwll Strodyr.	Quartzites with thin dark shales.
Lingula Flags . .	Mynydd Morfa Group.	
Doubtful Age . .	Pwll Crochan Group . .	Dark slates with obscure fossils probably Menevian or Upper Lingula Flags.
? Solva	Llech Dafad Group . .	Quartzites, green and purple sandstones ; obscure fossils.

The age and relationships of the various groups are briefly discussed, and reference is made to certain intrusive rocks which occur among the lower groups.

In view of the great thickness of some of the groups and of the bearing of their age upon the igneous rocks of Pencaer and Strumble Head it is proposed to map the area in detail.

REVIEWS.

I.—Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1912. 8vo ; pp. iv, 101, with 1 plate and 4 text-illustrations. London : printed for H.M. Stationery Office, 1913. Price 1*s*.

In this memoir, as usual, there will be found much to interest all geologists, whether their special studies are among the Archæan schists or on succeeding geological systems up to the time when Palæolithic Man occupied the country. In England and Wales field-work has been carried on in three districts: Denbighshire, Warwickshire and Staffordshire, and London with the south-eastern counties. In Scotland the districts comprise the West Highlands, North and Central Highlands, Kilmarnock in Ayrshire, and South Lanarkshire.

Attention is called to the occurrence in Ben Armine Forest, Sutherland, of an altered peridotite, which is in contact with gneisses of Lewisian type and granite intrusions, and was probably intruded prior to the movements which caused the schistosity of the rocks. The subsequent remarkable effects of granitization are described.

The mapping of some of the older Palæozoic rocks on the western borders of the Denbighshire Coal-field has been revised, and it has been found that the Tarannon Shale does not rest unconformably upon the Ordovician, but that the Llandovery Beds are present, and no evidence

of unconformity locally exists. Some modifications have been found necessary in the groupings of the strata classed as Millstone Grit and Lower Coal-measures, and an unconformity has been proved at the base of the Upper Barren Coal-measures in the Denbighshire district. In Lanarkshire evidence of unconformity in the Millstone Grit has been observed. A large tract near Tamworth, regarded on the old geological survey maps as Keuper Sandstone, has now been ascertained to consist of the Keele Beds or Upper Red Coal-measures. Some questions concerning the upper limit of the Keele Beds have yet to be solved.

Notes are contributed on the Lias and Cretaceous rocks of Mull (West Highland district), and particulars, illustrated by three maps, are given of the Tertiary igneous rocks. The discovery is recorded of numerous small hexagonal plates of blue corundum (sapphire), with other minerals, in an igneous matrix that consists of andesitic felsite and trachytic granophyre or syenite, with included blocks of baked sandstone and shale.

In the London district the transitional clays, loams, and sands, between the mass of London Clay and the Lower Bagshot Sand, have been separately mapped as the "Claygate Beds". Descriptions are given of the glacial and later drift deposits in the various districts.

In the Appendices there is a short article "On some Palæolithic Gravels near Swanscombe, Kent", by Mr. Reginald Smith (of the British Museum) and Mr. Henry Dewey (of the Geological Survey). They give results of a careful personal study of the successive Pleistocene deposits in the Barnfield Pit, about half a mile north-west of Swanscombe Church. Here, resting on the Thanet Sand, the top of which is about 90 feet above O.D., is a series of gravels, sands, and loams, about 25 feet thick, that are usually described as forming the 100 foot terrace. For about three weeks the authors employed two gangs of men, and examined every spadeful of material dug away in order to ascertain the nature and sequence of the flint implements. Their results may be summarized as follows:—

Upper Gravel . .	Several flakes and one good implement, "but further evidence is required as to the horizon."
Upper Loam . .	Said to contain white patinated ovates.
Middle Gravel . .	More advanced forms, with one or two ovates of St. Acheul character. Palæolithic implements of Early Chelles type.
Lower Loam . .	No implements.
Lower Gravel . .	Numerous flint flakes and some roughly cylindrical flints chipped at one end into a point or chisel-edge. Comparable with the Belgian type named after Strépy in Dr. Rutot's system.

It is regarded as not improbable "that the Middle Gravel represents the whole of the Chelles period and the transition to St. Acheul".

Records of borings at Lowestoft, Henlow in Bedfordshire, and Batsford in Gloucestershire, are communicated by Dr. A. Strahan. Those of Lowestoft and Batsford are specially important. At Lowestoft[1]

[1] Boring commenced 1902, not 1912.

the Chalk was proved to be 1,050 (possibly 1,055) feet thick; and it is interesting to note that at Norwich in Colman's Well a thickness of 1,152 feet of Chalk was proved, but not quite the full local thickness, there being some 35 or 40 feet of Chalk in the bordering hills not passed through. The occurrence of 11 feet of Upper Greensand is also of interest, as this formation (6 feet thick) was also recognized in the Norwich boring. Below the depth of 1,627 feet at Lowestoft, beneath Gault and Lower Greensand, there were 205 feet of pale mudstones, regarded as "Cambrian or Ordovician, probably the former". They yielded fragmentary remains of *Lingula* and *Orbiculoidea*. Water was obtained from the Lower Greensand, but the quality was medicinal.

At Batsford, or Lower Lemington, near Moreton-in-the-Marsh, the boring was carried out in 1901–4 by a Coal Syndicate. Coal-measures were reached at a depth of 1,021½ feet, but at the depth of 1,546 feet Silurian rocks were encountered. The Coal-measures were not of productive character, but it is possible that productive beds occur in the vicinity in proximity to Silurian rocks, as they do in the South Staffordshire Coal-field.

Another article of practical importance is on "The Copper Lodes of Inveryne and Kilfinan, Argyllshire", by Mr. C. T. Clough.

II.—Mines and Mining in the (English) Lake District. By John Postlethwaite, F.G.S., Assoc. M. Inst. M. E. 3rd ed. 8vo; pp. xii, 164, with geological map, 15 plates, and 29 other illustrations. Whitehaven: W. H. Moss and Sons, Ltd., 1913. Price 3*s*. 6*d*. net.

THE first edition of this work, issued in 1877, was favourably reviewed by John Morris in the Geological Magazine for 1878, p. 317; and a second and enlarged edition was published in 1889. In the present work much has been added, references being inserted to the later geological publications, together with lists of fossils and illustrations of a number of them. It would be well in a future edition to have the aid of a palæontologist in dealing with the names of species and the use of capital letters, etc. The main object of the work is, however, to describe the minerals and the mines, a practical and scientific subject with which the author is especially qualified to deal; and he has now added a considerable number of plans and sections of mines and veins, and some excellent views of quarries. Historical accounts of the coal-mining in Cumberland, and of the iron-mining in Cumberland and Furness, are given; and a synopsis of the State Papers relating to the mines in Newlands and the Smelting Works at Keswick (1547–80) has been appended. There is unfortunately no general index, and the illustrations are not systematically numbered; but the table of contents is full, and may suffice for the many who will appreciate the copious practical information.

III.—The Calvert Boring.

THE interesting and important record has now been published by Dr. A. Morley Davies and Mr. John Pringle (Quart. Journ. Geol. Soc., lxix, p. 308, 1913) on the strata proved in two deep borings at Calvert Station, on the Great Central Railway, in North Buckinghamshire. It exemplifies the need, expressed by Dr. Strahan in his Address to the Geological Society in February last, "that registration of deep borings in a Government Department should be made compulsory." Readers of the *Daily Mail* (October 18, 1911) will have been struck with the announcement, printed in bold type, of "Coal within 50 miles of London", and with the advertisement of "The Bucks Coalfields Syndicate, Limited". It appears that the notion that coal occurred was based on the fact that inflammable gas, termed 'coal gas', was encountered below depths of 380 and 443 feet. This was "taken as an evidence of the possible existence at a shallow depth of a deposit of bituminous coal"; and in some newspapers the statement was made that coal-seams had been struck at a depth of 530 feet. The presence also of "mottled red sandstone" was referred to as "very promising for coal at a shallow depth". The mottled beds are now shown (in the paper above-mentioned) to be stained Tremadoc shales (Cambrian, 443 to 1,398 feet); and they are overlain directly by Lower Lias. It is suggested, however, that the staining might be due to a former covering of Triassic strata. The Calvert gas, which is stated to resemble that obtained from Wigan Cannel-coal, occurred below the base of the Lias, and Dr. Davies and Mr. Pringle mention as a possibility that the gas "may have leaked into porous Triassic strata from underlying Coal Measures, possibly at some distance to the west or north-west".

IV.—Diffusion in relation to the Structure of Agates, etc.

Geologische Diffusionen. By R. E. Liesegang. pp. viii + 180, with 44 figures in the text. Dresden and Leipzig: Theodor Steinkopff, 1913.

GEOLOGISTS interested in the structure of agates, concretionary nodules, and similar objects, should not fail to read Dr. Liesegang's extremely fascinating book. Recent chemical work on diffusion has thrown quite a novel light upon the possible cause of the markings characteristic of such structures, but may not be generally known to geologists, because some of the journals in which many of the original papers appeared do not usually circulate among them. The author has therefore done excellent service by bringing together the somewhat scattered literature on the subject, and showing how closely the results obtained in the laboratory parallel the phenomena actually met with in nature. A valuable and important feature of the book consists of the extensive series of experiments on diffusion which is interwoven in the text to illustrate the particular points dealt with. The salts and materials used in them are all easily procurable, and the careful explanations render it easy to repeat any of the experiments.

The scope of the book is comprehensive in character. It opens

with a discussion of diffusible substances, the geological media which admit of diffusion, and the general characters of diffusion; the various types of structure are then treated in detail. The author shows that diffusion has been responsible, moreover, for the alterations that have sometimes occurred in ore-deposits, and for the formation of certain pseudo-fossils, such as, for instance, the once famous *Eozoon canadense*. Two indices, of names and subjects, which bring the book to a close, add to its usefulness.

V.—Determinative Mineralogy with Tables. By J. Volney Lewis. 8vo; pp. v + 151, with 68 figures in the text. New York: J. Wiley and Sons, 1913. Price 6*s.* 6*d.* net.

THIS book is designed to meet the needs of students and of mining engineers, and treats not only of minerals of economic importance but also of many of the rarer species; altogether 380 minerals are included.

In the text we find a brief account of the apparatus, reagents, and methods to be used in 'wet' and in 'dry' tests, and of the principal reactions of the elements. The simple forms of crystals are enumerated and illustrated by fifty-seven figures of various minerals; for an explanation of the face-indices and for other details the reader is referred to textbooks. There is a good glossary of technical terms, and a table of the elements with their atomic weights.

The tables are based very largely on those of Brush and Penfield, but are modified and much condensed; the relative importance of the minerals is indicated by the type in which the names are printed. The determinations are made to rest almost wholly on chemical tests, and no mention is made of the optical properties of minerals. Tables for the determination of rock-forming minerals, on the other hand, commonly neglect the chemical and appeal only to the physical properties. Now that the optical properties of so many minerals are well established, and the use of the petrological microscope has become so widespread, a combination of the two types of tables should be quite possible, and any determinative mineralogy which does not seek to combine the two must be considered a little behind the times.

W. C. S.

VI.—United States Geological Survey.

1. Bulletin 502. The Eagle River Region, South-Eastern Alaska. By Adolph Knopf. pp. 61, with 3 figures in the text and 5 plates (including 3 maps). 1912.

THE area, which has been mapped on the 1 inch scale, embraces a third of the Juneau gold belt of South-Eastern Alaska.

Three large glaciers come down from the Coast Range to within 100 feet of sea-level: they are shown to be retreating. There is evidence that at one period the country was glaciated to 3,400 feet above sea-level, the main ice-stream flowing south-east down the Lynn Canal. The absence of hanging valleys supports the idea that

the fjords of this area are due, not to glacial erosion, but to the drowning of a drainage system only slightly modified by glaciation.

The whole of the area between the Coast Range and the coast is occupied by a group of slates and greywackes known as the Berners Formation, probably of late Mesozoic age. These are intercalated with volcanic breccias, tuffs, and augite melaphyres. The Coast Range itself consists of quartz-diorite, which is regarded as of late Cretaceous age. The slates become metamorphosed into schists in the neighbourhood of the quartz-diorite, which itself is markedly gneissose at its margins.

The gold belt is contained wholly within the slates; there are no prospects in the schists or in the quartz-diorite. Ore-bodies occur either as stringers, fissure veins, or occasionally as mineralized dykes.

The dykes belong to a group of minor intrusions of uncertain age, and include diorites, albite diorites, lamprophyres, and gabbros. Their mineralization usually takes the form of intense albitization. Another frequent result is the production of abundant apatite in the altered wall-rocks. Some of these mineralized dykes carry low-grade gold ores, which indicates a magmatic origin for the gold deposits in this area.

Pillow-lavas are recorded at one locality, and their occurrence in an area in which albitization is so prominent a feature would suggest affinities with the spilitic facies. However, the pillow-lavas appear to consist of augite with only a little interstitial material of low refractive index and to belong to the augite melaphyre series of the Berners Formation, whereas the albitization takes place in dykes probably younger than the quartz-diorite of the Coast Range.

The bulletin contains details of the gold prospects in the area, and the geological work has done much to show in what directions fresh ore-bodies should be sought.

2. Bulletin 503. Iron-ore Deposits of the Eagle Mountains, California. By E. C. Harder. pp. 81, with 4 figures in the text and 13 plates (including 6 maps). 1912.

SITUATED in the waterless desert of South California, and some 40 miles from the nearest railway, the Eagle Mountains had been visited only by hasty prospecting parties until the district was surveyed in 1909. This survey located deposits of very pure iron-ore, and it is estimated that about fifty million tons of good ore are available in the northern part of the range. It is thought that the establishment of blast furnaces and steel plants in South California will have for its immediate result the development of these Eagle Mountain ores.

The geological structure of the northern part of the range is that of an oval dome. The centre is occupied by a small outcrop of gneiss and schist; these are surrounded by a series of quartzites and schistose arkose, overlain by a second quartzite with interbedded dolomite lenticles. Into these beds two large sills of quartz-monzonite have been intruded, causing the metamorphism of the quartzites and dolomite. It is in the dolomite horizons and in the surrounding

rocks that the iron-ores have been formed. Five types of deposit are recognized: (1) beds and irregular masses of hematite representing nearly complete replacements of dolomite; (2) layers of hematite in crystalline dolomite; (3) small replacement deposits in sediments at the contact of minor quartz-monzonite intrusions; (4) veins in quartzite; and (5) veins in quartz-monzonite. The first type includes quite 80 per cent of the ore in the district. The ore is now in the form of hematite, but the occurrence of pseudomorphs shows that magnetite and pyrites were the original minerals formed by the replacement. A consideration of the ore-bodies and of the associated rocks shows that they result from the replacement of dolomite by ore-bearing solutions of deep-seated origin: the replacement followed the intrusion of the quartz-monzonite sills, but it preceded certain minor intrusions of aplite, quartz-diorite, and soda-syenite-porphyry.

No fossils having been found, nothing is known of the precise age of the quartzites or of the periods at which the intrusions took place.

3. Bulletin No. 530 (1913) consists of "Contributions to Economic Geology (Short Papers and Preliminary Reports). Part I.—Metals and Non-metals except Fuels". Part II, on "Mineral Fuels", was noticed in the Geological Magazine for July (p. 322). In the work before us there are reports on gold, silver, copper, lead, zinc, iron, manganese, aluminium ores, and on some rare metals such as vanadium, carnotite, etc. There are notes and bibliographies on clays, fuller's earth, building stone, gypsum, glass-sand, asphalt, abrasive materials, phosphates, mineral paints, sulphur, graphite, etc.

Bulletin No. 537 (1913) is on "The Classification of the Public Lands", by Mr. George Otis Smith and others. It contains accounts of the laws relating to agricultural, mineral, coal, and other lands; and of the methods of classification of lands and their valuation in reference to various minerals, water-power and reservoir sites, public water reserves, etc. It should furnish useful information and suggestions to the many owners and land-surveyors now concerned in this country in the valuation of estates.

4. Water-supply Paper No. 259 (1912), by Messrs. M. L. Fuller and F. G. Clapp, deals with "The Underground Waters of South-Western Ohio", containing a general description of the topography and geology, and special accounts of the geology and water prospects of each county. The chemical character of the waters is discussed by Mr. R. B. Dole, who considers the suitability of various waters for domestic, industrial, and medicinal purposes, likewise the physical qualities of waters, the suspended mineral matter, the growths of microscopic plants, and the questions of purification and softening. No. 293 (1912) is on the "Underground Water Resources of Iowa", a voluminous report separately printed also by the Iowa Geological Survey (see Geol. Mag. 1913, p. 226). No. 297 (1913) consists of part iii of a "Gazetter of Surface Waters of California", by Mr. B. D. Wood, dealing with the Pacific coast and Great Basin streams. No. 300 (1913), by Messrs. H. D. McGlashan and H. J. Dean, is on the "Water

Resources of California", comprising part iii of Stream Measurements. No. 310 (1913), by Messrs. F. F. Henshaw, H. D. McGlashan, and E. A. Porter, is on the "Surface Water Supply of the United States", being part x, on the Great Basin; and No. 311 (1912), by Messrs. McGlashan and R. H. Bolster, is on the same general subject, being part xi, on the Pacific coast in California. No. 313 (1913), by Messrs. Henshaw and G. L. Parker, is part ii of a report on the "Water Powers of the Cascade Range", well illustrated by maps and diagrams. No. 316 (1913) is a brief account of the "Geology and Water Resources of a portion of South-Central Washington", by Mr. G. A. Waring, who describes the physical features, geology, and agriculture, with accounts of the springs, wells, and systems of irrigation.

VII.—Geological Survey of Western Australia.

BULLETIN No. 42 (1912) comprises "Contributions to the Study of the Geology and Ore-deposits of Kalgoorlie, East Coolgardie Goldfield", part i, by Messrs. E. S. Simpson and C. G. Gibson. The geological structure of the area is described by Mr. Gibson, who states that the original rocks were shales, sandstones, grits, and conglomerates, with possibly interbedded lava-flows, that were deposited probably in pre-Cambrian times on a gneissic or granite floor. The strata were afterwards tilted into highly inclined positions and subsequently invaded by gabbros, diabases, porphyrites, pyroxenites, peridotites, etc. Still later there were intrusions of quartz- and felspar-porphyries, and further earth-movements that gave rise to shearing and faults. Along the shear-planes the auriferous lodes are developed. Accounts are given of the various rocks and mode of occurrence of the ore-deposits. Mr. Simpson then describes the mineralogy of the ore-deposits, the surface and underground waters, and the telluride ores in particular. In a prefatory note the Government geologist, Mr. A. Gibb Maitland, remarks that the results of the researches indicate the probability that the whole of the ore-deposits are likely to persist to the greatest depth to which mining is possible, and that the grade of ore below 2,000 feet may be expected to be as variable as it is above that level. The memoir is well illustrated by maps, views, and microphotographs.

VIII.—Congo.

Annales du Musée du Congo Belge. Géologie, sér. iii, tom. i, fasc. 1: La Faune paléocène de Landana. Par Vincent, Dollo, et Leriche. 4to. Bruxelles, 1913.

ALTHOUGH the existence of these Tertiary beds has been known since 1877, this is the first time their contents have been systematically described and figured. Pechuel-Loesche (1877), d'Andrade (1904), and others have visited the neighbourhood, but beyond fish-remains and some casts of Mollusca few recognizable fossils seem to have been found. The present series have been obtained by M. Diderrich, and show a definite Lower Eocene or passage to Cretaceous facies. The fossils occur in blocks of compact white limestone, recalling white chalk of varying consistency, and

are nearly always in the state of casts, the moulds of which retain quite sharply the impression of the ornaments of the shell surface, much the same as in the case of the English fossils from the Chalk Rock. M. Vincent describes the Mollusca, M. Dollo *Podocnemis congolensis*, and M. Leriche some new fishes, *Hypolophites mayombensis*, *Myliobatis dispar*, and a couple of Agassizian species of *Lamna* and *Odontaspis*. Leriche also gives a sketch of the Eocene fish fauna of the west coast of Africa, which confirms the opinion that the general fauna is of early Eocene age. The papers are well illustrated.

IX.—Geological Explorations in Northern Assam.

The Records of the Geological Survey of India, vol. xlii, pt. iv, 1912, contains accounts of two traverses made by geologists accompanying punitive expeditions against the hill tribes of Northern Assam.

E. H. Pascoe, M.A., gives an account and sketch map of "A Traverse across the Naga Hills of Assam from Dimapur to the neighbourhood of Sarameti Peak". The traverse is joined up with earlier mapping by Hayden further to the north. Near Dimapur the Tertiaries are represented by the Tipam sandstones. These are bounded on the east by a reversed fault, bringing in the sandstones and carbonaceous shales of the Disang Series. There is a band of serpentine, derived from gabbro and peridotite intrusions probably of pre-Disang age. The Chimi conglomerate forms an important horizon as it separates the Disang Beds to the west from the Makwari Beds to the east; these latter differ from the Disang Series only in the degree of their metamorphism, which increases eastwards. Blue slates of good roofing quality occur in the Tepe and Tuzu Rivers. The entire absence of limestone between the Tipam Beds and Sarameti Peak is notable. Correlation with other areas is difficult; provisionally the Disang Series is correlated with the Negrais, and the Makwaris with the 'Axials' of Burma.

J. Coggin Brown, M.Sc., accompanied the Abor Expedition of 1911–12. The geological results of this expedition are given in "A Geological Reconnaissance through the Dihong Valley". This was practically untouched ground, and the traverse adds considerably to our knowledge of the mountains bordering Upper Assam. After leaving the alluvial deposits near the mouth of the river, the road crosses Pleistocene gravels resting on Siwalik sandstones containing fragments of lignite. These Tertiary beds are succeeded by carbonaceous shales and quartzites of Gondwana age, associated with a large series of basalts—the Abor Volcanic Series. The junction between Siwalik beds and Gondwanas is probably an overthrust. Above the Gondwanas the route traverses a large series of slates, phyllites, and dolomites, comparable with the Daling and Baxa Beds of the Darjeeling area. These are followed by true mica-schists. There is frequent repetition of similar groups of rocks, which is due to the existence of closely-packed sinuous folds, often overfolded, and having a general N.E. and S.W. trend. Little of economic value was found, the coal being too inaccessible to pay for the working.

X.—Brief Notices.

1. The Hils Basin.—Dr. H. von Koenen discusses the disturbances of the Hils Basin in the Jahresb. Niedersäch. geol. Ver. Hannover, 1913. He describes it as "a basin due to compression, with uptilted margins, its interior being filled with essentially younger beds less strongly influenced by the pressure".

2. Waters of Kharga.—Mr. G. W. Grabham has published in the *Cairo Scientific Journal* (No. 61, vol. v, October, 1911) a paper dealing with the mechanics of wells, the choking of boreholes by deposition, and the exhaustion of strata. This is a reply to Mr. H. J. L. Beadnell's paper, and the whole discussion is interesting and instructive.

CORRESPONDENCE.

A SUPPOSED SUBMERGED FOREST IN SOUTH-WEST SCOTLAND.

Sir,—In your review of Mr. Clement Reid's book on submerged forests you cite the statement that in "Scotland the Neolithic deposits seem to be raised beaches instead of submerged forests". There is what appears to be a submerged forest bed in a small creek called Brighouse Bay, a little west of the estuary of the Dee on the coast of Galloway. It was incidentally noticed in a paper published by the Society of Antiquaries of Scotland in 1875. Some presumably large antlers of (red) deer were recorded as from the "submerged forest". The district is outwardly much like that of South Devon, viz. with low-level beach-platforms, drowned valleys, and what seem to be submerged forest clays. The paper referred to is on the exploration of the Borness Cave, and the mention of the submerged forest is on p. 11 of the reprint. The late Mr. A. J. Corrie and myself were solely responsible for the geological part of the report, and we were guided by the South Devon raised beaches in our identification. It is quite possible we were mistaken. Perhaps some of our readers may be acquainted with Brighouse Bay.

A. R. Hunt.

Torquay.
September 8, 1913.

NOTE ON THE NAME 'CHARMOUTHIAN'.

Sir,—D'Orbigny in 1852 divided the Lias into three stages which he called respectively the Sinemurian, the Liassian, and the Toarcian, and in 1864 Mayer-Eymar proposed the name 'Charmouthian' to take the place of d'Orbigny's Liassian. As pointed out by Mr. W. D. Lang in this Magazine (1912, p. 284), this middle stage of d'Orbigny and Mayer-Eymar included more than has usually been assigned to the Middle Lias in England. I am not now concerned with the grouping of the zones, but with the form of the name which has been adopted by most French geologists in preference to the Pliensbachian of Oppel.

The name is, of course, taken from the little town of Charmouth in Dorset, near which the Middle Lias is well exposed in the cliffs, but it is unfortunate that Mayer-Eymar should have tried to latinize such a name as Charmouth without making any inquiry as to its ancient form. It is a recognized custom or rule that when such names are

derived from those of places or districts they are based on the Roman name if there was one, or on the earliest known form of the name.

I am informed by Dr. H. C. March, F.S.A., that Charmouth is generally believed to be the place called *Carrum* in the Anglo-Saxon Chronicle, which records a battle fought there by King Egbright against the Danes in A.D. 833, and this seems to be the earliest mention of the place, which was never a port of any importance. All the editors and commentators identify Carrum with Charmouth, and it is this ancient form of the name which should be taken as the basis of a stratigraphical term and not the uncouth modern name of Charmouth. I think, therefore, that if our French colleagues continue to use a name taken from this place they should substitute *Carrumian* for Charmouthian, on the same principle that we write Callovian, not Kellawaysian; Bajocian, not Bayeuxian; and Cenomanian, not Lemansian.

PS.—Since the above was written and printed Mr. Lang has proposed the name '*Carixian*' for the lower part of the Charmouthian or Pliensbachian stage, accepting Bonarelli's name of *Domerian* for the upper part, and he derives this name from "the Carixa of Ravennas", which is cited in Roberts' *History of Lyme Regis* as the ancient name of Charmouth (see GEOL. MAG., September, 1913, pp. 401–12).

On this proposal I have several criticisms to offer. In the first place, Mr. Lang remarks that he has "already advocated the propriety of employing the term Charmouthian strictly with its original connotation", and yet he suggests as a new name for a part of this Charmouthian a term taken from what he accepts as the Latin name of the same place. Surely if Carixa was the Roman name for Charmouth it should be used as the basis for the name of the whole Charmouthian stage.

Secondly, the "Chorography of Ravennas" is not a very good authority; its author is really unknown and even the date of it is somewhat uncertain. Moreover, as Mr. Lang himself points out, the name Carixa is probably a latinization of the Celtic words *car-isca*, meaning the River Char, not the place. As a matter of fact, it is very doubtful whether there was any settlement at the mouth of the Char until the time of the wars between the Saxons and Danes.

Thirdly, we seem in danger of being saddled with too many of these latinized names. They are very useful as names for stages, but when it comes to introducing sub-stages with similar names I for one protest. The division of a system into two or more series, of a series into stages, and of a stage into any number of zones seems quite sufficient for practical purposes. The addition of sub-stages merely imposes an unnecessary burden upon the memory.

In England the stages of the Lias have hitherto been called Lower, Middle, and Upper. If it is thought more convenient to divide the series into four or five stages, let us have geographical names for them, but there is no good reason for burdening our nomenclature with a double set of such names.

A. J. JUKES-BROWNE.

TORQUAY.
September 8, 1913.

THE LATE HERBERT KELSALL SLATER.

SIR,—I am informed by Dr. W. F. Smeeth, the principal officer of the Geological Department of Mysore, that a fund is being formed to make some provision for the family of Mr. H. K. Slater of that department, who died recently from the bite of a large Russell's viper while engaged in Geological Survey work in the Shimoga District. An obituary, in which his services to geology are recorded, appeared in this Magazine in July last. He leaves three young children almost entirely unprovided for, and it is urgently necessary to raise a sum sufficient for their upbringing and education.

Contributions may be sent either to Dr. W. F. Smeeth, Bangalore, India, or to me at the address below.

JOHN W. EVANS.

IMPERIAL INSTITUTE,
LONDON, S.W.

OBITUARY.

SIR GEORGE HOWARD DARWIN,
K.C.B., M.A., LL.D., D.Sc., F.R.S.

BORN JULY 9, 1845. DIED DECEMBER 7, 1912.

IN his opening Address to the British Association the President, Sir Oliver Lodge, writes (Birmingham, September 10): "Through the untimely death of Sir George Darwin the world has lost a mathematical astronomer whose work on the tides and allied phenomena is a monument of power and achievement. So recently as August, 1905, on our visit to South Africa, he occupied the Presidential Chair." It was on his return to England after his visit to South Africa that he received the honour of Knight Commander of the Bath from His Majesty.

The second son of the late Charles R. Darwin (author of *The Origin of Species*, etc.), George Darwin was born at Down, Kent, in 1845, and was educated privately by the Rev. Charles Pritchard (later Savilian Professor of Astronomy at Oxford). He entered Trinity College, Cambridge, in 1864, and graduated as a Second Wrangler and Smith's Prizeman in 1868, and in that year he was elected to a Fellowship at Trinity College, which he held 1868–78, and to which he was re-elected in 1884. At first he studied the law, and was called to the Bar in 1874, but returned to Cambridge, where he spent the rest of his life, devoting himself to Solar Mathematics. His *Collected Papers*, which form four volumes, were recently published by the Cambridge University Press. In 1884 he was chosen Plumian Professor of Astronomy in Cambridge.

Sir George Darwin's writings had a most important bearing on Dynamical Geology, especially "On the influence of Geological Changes on the Earth's Axis of Rotation" (Phil. Trans., 1877), "On the bodily Tides of viscous and semi-elastic Spheroids and on the Ocean Tides on a yielding Nucleus" (op. cit., 1879), "On the Precession of a viscous Spheroid and on the Remote History of the Earth" (op. cit., 1879), and "On the Secular Changes in the

Elements of the Orbit of a Satellite revolving about a Tidally Distorted Planet" (op. cit., 1880).

Another of his memoirs may be appropriately recalled, bearing upon the same subject as that recently dealt with by Colonel Burrard (GEOL. MAG., September, 1913, pp. 385–8) and the Rev. O. Fisher: "On the Stresses caused in the Interior of the Earth by the Weight of Continents and Mountains" (op. cit., 1882).

In 1877 George Darwin became acquainted with Lord Kelvin, who from that time took a warm interest in all his work and greatly influenced his subsequent researches.

In 1884 he married Maud, daughter of Charles du Puy, of Philadelphia, and leaves two sons and two daughters. His eldest son, Charles, was a scholar of Trinity in 1905, and graduated as Fourth Wrangler in Mathematics in 1909.

Sir George delivered a course of lectures at Boston, U.S., in 1897 under the title of "The Tides", which was subsequently printed as a popular volume entitled *The Tides and Kindred Phenomena of the Solar System* (1898).

He was a Vice-President of the International Geodetic Association, a member of the Meteorological and Solar Physics Committees, Doctor of nine Universities, Foreign Honorary Member of twenty Societies and Academies, and Foreign Correspondent of twelve others. He served as a member of Council of the Royal Society for seven years, and as Vice-President for two years, and was President of the Cambridge Philosophical Society and Vice-President of the Astronomical Society.

Sir George Darwin was also the recipient of the Royal Astronomical Gold Medal in 1892, Royal Medal, Royal Society, in 1884, and the Copley Medal in 1911, and several others.

TEMPEST ANDERSON, M.D., D.Sc., F.G.S.

BORN 1846. DIED AUGUST 26, 1913.

THE death is announced from enteric fever whilst on his voyage home from the Philippine Islands of Dr. Tempest Anderson, of York. The son of the late Mr. William C. Anderson, M.R.C.S., a member of an old and well-known Yorkshire family, Dr. Tempest Anderson was born at York in 1846. He was educated at St. Peter's School, York, and had a distinguished student's career at University College, London. He was a well-known scientist. As President of the Yorkshire Philosophical Society he spent a great deal of time and much money in its interests, and it was through his influence that a new lecture hall was recently added to the York Museum. Dr. Anderson's special branch of study was volcanic phenomena, and this subject, illustrated by photographs, he brought on many occasions before the British Association. He was author of *Volcanic Studies in Many Lands*, 1903 (see review by W. H. Hudleston, GEOL. MAG., 1903, p. 160). After the terrible eruption in May, 1902, of the Soufrière, in St. Vincent, one of the West India Islands, he and Dr. J. S. Flett were commissioned by the Royal Society to investigate the matter. Their joint report was published in the *Philosophical Transactions* for 1903. Dr. Anderson revisited the West Indies in 1907, and gave an account

of the subsequent changes in the volcanic districts of St. Vincent and Martinique, his report being published in 1908. Dr. Anderson was Tyndall lecturer on volcanoes at the Royal Institution. Professionally he was a specialist in diseases of the eye. He took a deep interest in the promotion of open spaces and garden cities. He was an extensive traveller, and there were very few places where volcanic eruptions were known to have occurred that Dr. Anderson had not visited. He was a noted Alpine climber and photographer, and had produced some splendid views of places of interest which he visited during his travels. Among the numerous appointments and distinctions which he held were the following: Consulting ophthalmic surgeon to the York County Hospital; Fellow of University College, London; member of Council and former Vice-President of the British Association; President of the Museums Association, 1910; and member of the Council of the Geological and Royal Geographical Societies. Dr. Tempest Anderson was one of the five original Trustees[1] of the 'Sladen Fund' established by his sister, Mrs. Walter Percy Sladen, F.L.S., for the advancement of scientific research in Anthropology, Zoology, Botany, and Geology. Dr. Anderson was unmarried.[2]

WILLIAM HENRY SUTCLIFFE, F.G.S.

BORN SEPTEMBER 25, 1855. DIED AUGUST 18, 1913.

W. H. SUTCLIFFE was born at Ashton-under-Lyne, educated at Manchester Grammar School and Owens College (now Manchester University). Trained for the cotton trade, he was for some time manager of a cotton-mill near Rouen. In 1885 he became manager for Messrs. E. Clegg & Sons' cotton-mills at Shore, Littleborough, near Rochdale, Lancashire, and subsequently became one of the managing directors. The firm is one of the largest cotton manufacturers in the district and employs about 1,500 workpeople.

Apart from his business Mr. Sutcliffe was best known as a geologist and archæologist and a member of many scientific societies. He early took an interest in the remains of primitive man found on the hills in the neighbourhood of Rochdale, and the fruits of his labours and that of other workers are to be seen in the fine collection of flint implements and other remains in the cases of the museums at Rochdale and Manchester University.

One of his most interesting contributions was a joint paper with Mr. W. A. Parker, F.G.S., on "Pigmy Flints, their provenance and use", in which they almost conclusively proved that the use of these minute flints was as skin-scrapers. He also communicated a paper to the Manchester Literary and Philosophical Society on March 18 last, on "A Criticism of some Modern Tendencies in Prehistoric Anthropology". This was an admirable study of recent theories as

[1] Dr. Tempest Anderson, F.L.S., F.G.S.; Henry Bury, M.A., F.L.S., etc.; Professor Herdman, F.R.S.; T. Bailey Saunders, M.A.; and Dr. Henry Woodward, F.R.S.

[2] For many of the above particulars we are indebted to the *Morning Post*, August 29, 1913.

to the antiquity of man, and was a careful weighing and sifting of the evidence in connexion with some of the discoveries of recent years. He strongly attacked the theory that the so-called 'Eoliths' were the work of man, and also the idea that the Galley Hill skeleton found some years ago in Kent and the one found near Ipswich were of very early type, and for this object he visited Ightham, Kent, and the locality where the Ipswich skeleton was found.

As a geologist he has been the means of considerably extending our knowledge of the palæobotany of the Lower Coal-measures; and the 'Bullion Mine', Shore, near his residence, has become widely known on account of the rich harvest it has yielded of specimens new to science, and his name has been commemorated in *Tubicaulis Sutcliffei* and in *Sutcliffia insignis*.

He has also been associated with other well-known local geologists in the discovery of the very rich fauna in the Middle Coal-measures at Sparth, Rochdale, about which Dr. H. Woodward gave a paper at the British Association Meeting at York in 1906, when he named a new species of fossil arachnid, *Geralinura Sutcliffei*, and this specimen with many others have been presented by Mr. Sutcliffe to the Geological Department of the British Museum (Natural History).

Most of his holidays in recent years have been devoted to geological investigation, and he invariably returned with many valuable specimens, some of which have enriched the Rochdale and Manchester Museums. One of his recent finds was a fine specimen, 20 feet long, named *Plesiosaurus homospondylus*, from the Lias of Saltwick Bay, near Whitby, which is preserved in the Manchester Museum.

In one of his archæological investigations he endeavoured to trace the Roman Road over Blackstone Edge (Pennine Range) north-east of Rochdale, and had a large portion of ground uncovered beneath the turf and heather so as to trace its course for a considerable distance.

Mr. Sutcliffe was elected a Fellow of the Geological Society in 1903, and contributed a joint paper to that Society in 1904 on *Eoscorpius sparthensis*, sp. nov. (Quart. Journ. Geol. Soc., vol. lx, p. 394).

He was a member of the Manchester Geological Society and University Geologists' Association, the Manchester Literary and Philosophical Society, and many other bodies. He was also a member of Council of the Manchester Museum.

He joined the Rochdale Literary and Scientific Society in 1886, became a member of Council in 1898, and was last year elected President, when he gave a very interesting address on "The Evolution of Tools", to illustrate which he had on exhibition about 500 specimens, showing the development of the principal form of tools demonstrating the evolution of the textile industry.

He had a large circle of English and foreign friends amongst men of science, including the Editor of this Magazine. Mr. Sutcliffe was in private life and in his scientific pursuits one of the kindliest and most genial of men.

For some months he had been in failing health, and died at Weymouth on August 18 last, to the deep regret of his many friends. He leaves a wife, one son, and two daughters to mourn his loss.

S. S. P., W. A. P.